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TRAINING IN PACAF F-16 MAINTENANCE UNITS: FINAL REPORT FOR PHASE I OF THE SQUADRON LEVEL TRAINING RESEARCH PROJECT

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The objective of the Squadron Level Training (SLT) research project is to examine training at operational support units in the AF and determine if it can be conducted more efficiently and effectively using training technologies. This paper documents the conduct and findings of Phase I of this project. The goal of Phase I was to develop an understanding of the training environment, develop a preliminary approach for relating training system needs to training technologies, and suggest directions for continued research in this area. Researchers were able to identify a number of specific training problems at the unit level through the use of interviews and archival research. These problems were subsequently related to potential technology solutions.

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Preface

This report documents the activities and findings of Phase I of the Squadron Level Training (SLT) research program. It specifically examines the current training environment at selected operational AF units (i.e., PACAF F-16 maintenance units), identifies training system needs, and relates them to potential technology solutions. This report is the culmination of work performed by Universal Energy Systems, Inc. and the Armstrong Laboratory under Task 50, Contract No. F41689-86-D-0052.

Summary

The objective of the Squadron Level Training (SLT) research program is to examine training at AF operational units and determine if it can be conducted more efficiently and effectively using training technologies. A number of trends in the AF environment prompted concern over unit-level training and led to the initiation of SLT research. These trends included reduction in force size, increased skill demands placed on individuals, decreased reliance on resident training, increased complexity of weapon systems, and increased training responsibility at the unit level. This paper documents the conduct and findings of Phase I of a two phase project. The goal of Phase I was to develop an understanding of the training environment, develop a preliminary approach for relating training system needs to training technologies, and suggest directions for continued research. In Phase I, researchers developed a structured interview based on the major functions of the unit-level training system including planning and programming, development and delivery, and management and evaluation of training. They administered the interview to PACAF F-16 flying and maintenance units, as well as personnel at higher headquarters. Content analyses of the interview data revealed a number of general training problems in the unit-level training system. Researchers subsequently developed an ISD-based framework to further analyze the Phase I findings and to identify potential technological solutions. Researchers identified the specific deficiencies underlying the general training problems and determined that AF training technologies addressed each of the deficiencies to some degree.

TRAINING IN PACAF F-16 MAINTENANCE UNITS: FINAL REPORT FOR PHASE I OF THE SQUADRON LEVEL TRAINING RESEARCH PROJECT

I. INTRODUCTION

The Air Force training system is one of the largest and mostcomplex training systems in existence. When not engaged in combat,the entire Air Force can be viewed as "in training" to prepare forwar. Air Training Command (ATC), for example, conducts over 1400formal technical training courses as well as flying training (AFM 50-5, 1990; C. Yelverton, HQ ATC/ACC, personal communication, 6 June, 1990). Professional military and ancillary training is also conducted at various levels of command throughout the Air Force. It has been estimated that, during any given year, at least half of the total Air Force is involved in some aspect of training ranging from short-term skills upgrade training to multi-year professional and technical development programs (Johnson, Green, Soldwisch, Turner, & Wall,1988).

Training managers at all levels continually weigh many inputs in deciding how to best achieve adequate levels of job performance to ensure mission success. Major constraints management must deal with include national and military policy positions, mission requirements, manpower qualifications, funding, and systems technology. Frequently one or more of these factors can undergo rapid change or redirection which require major revisions to both short- and long-term training goals. The Air Force must continually adapt and restructure its training within the context of these dynamic constraints.

Recent international and domestic trends have combined to impact on the factors affecting Air Force training direction. Reductions in funding and force size, restructuring of career fields, deployment of active duty and reserve personnel, increased importance of on-the-job training (OJT), changing labor pool demographics, and advances in technology are shaping the answers to the questions about the "who, what, when, where, and how" of training. In the future, as Air Force training continues to evolve, it is anticipated that units will continue to be responsible for a large share of the training burden. Since fewer people will be available to train increasing numbers of tasks, it is anticipated that training technologies will be needed at the unit level to increase the efficiency and effectiveness of training.

The Air Force Human Systems Division (HSD), in its role as the principal advocate for the human operator across weapon and support systems, conducts programs of research and advances technology to prepare the human operator for mission accomplishment. In response to a commitment at all levels of Air Force command to increase training efficiency, the HSD has taken a lead role in the investigation of how technologies can be used to address the training requirements generated by an increased emphasis on unit training.

The Human Resources Directorate of the Armstrong Laboratory (AL/HR) is supporting HSD by identifying and evaluating the role of training at the unit level through a research initiative referred to as Squadron Level Training (SLT). (Note. For the purposes of this project, "squadron" and "unit" generically refer to wing, base, squadron, or unit. Figure 1 displays the types of training encompassed by the term "squadron level training." A list of acronyms and terms is contained in the Glossary [Appendix A].) SLT research is concerned with evaluating the potential for utilizing currently available and planned training technologies at the unit level. The primary goal of the SLT research initiative is reflected by the following question: Can training done at the operational unit be done more effectively and efficiently? This research initiative is the initial step toward understanding the requirements of SLT and the potential role of HSD technologies in enhancing unit training. The ultimate goal of this research stream is the development of a Science and Technology investment strategy for continued research and development (R&D) of training technologies.

The objective of the first phase of SLT was to assess qualitatively the state of training in selected operational AF units, namely F-16 aircraft maintenance units of the Pacific Air Force (PACAF). Following is a list of training issues central to Phase I of the study:

1. Trends in current unit training requirements, that is, the difference between a trainee's skills and knowledges and those required by the job, including type, content, and amount of job-related and ancillary training (e.g., number of trainees, length of training, frequency of training);
2. Existing training capabilities of the unit, that is, the resources available to support training (e.g., time away from primary duties, materials, equipment, experienced personnel to serve as instructors);
3. Identification of factors which facilitate or impede unit-level training (e.g., anticipated impact of increased unit-level training).
4. Current training system needs and opportunities for increasing the efficiency and effectiveness of training at the operational unit, including identification of technologies needed to support training;

Outcomes from this phase of the SLT investigation will be evaluated to determine the necessity of further research. It is hoped that this preliminary research will provide a context and suggest directions for a more rigorous and systematic analysis of AF unit level training in a subsequent phase.

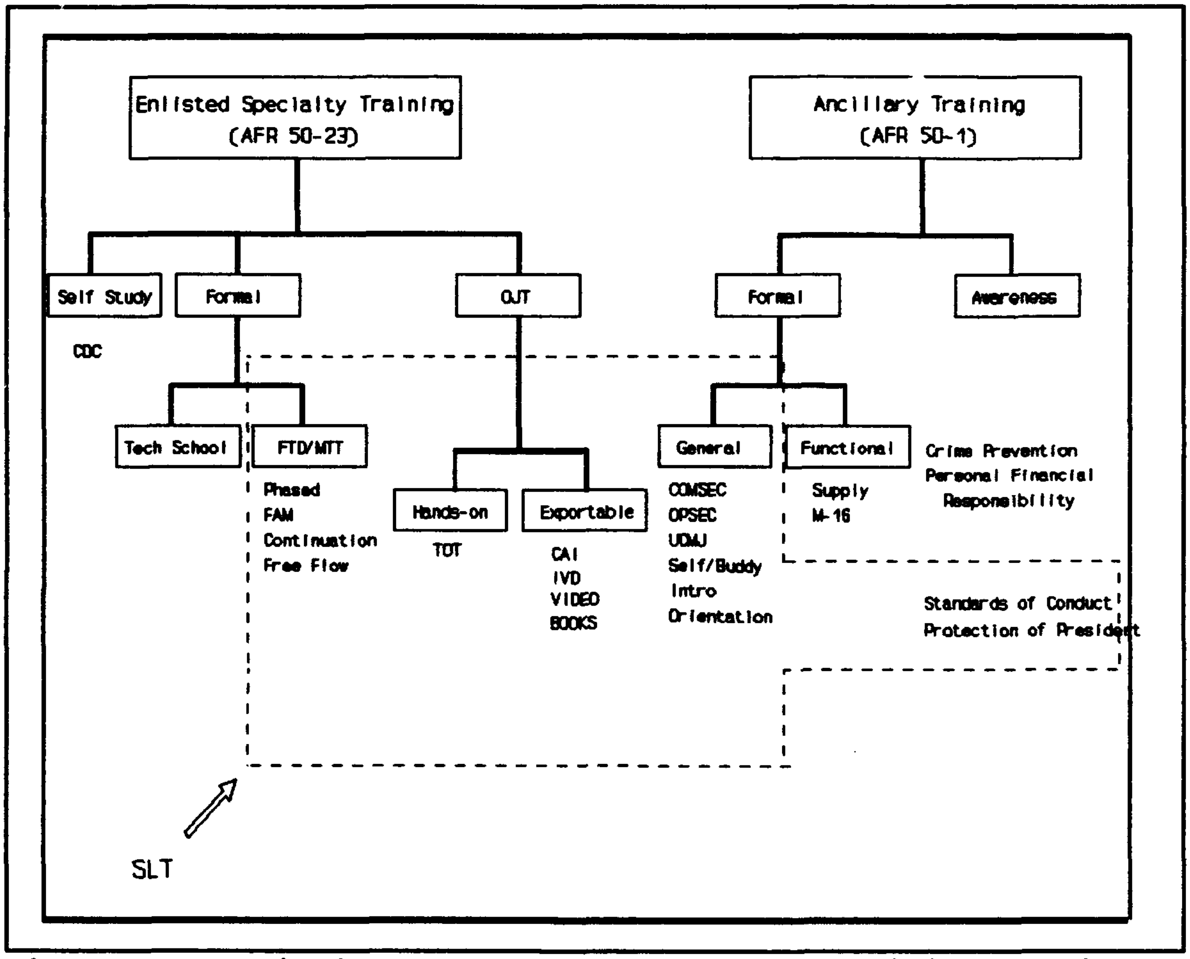

Figure 1. Depiction of the Squadron Level Training Domain

This report, then, documents the conduct and findings of the first phase of SLT research in the maintenance field. The following sections present the research methodology, results, and conclusions of the research with regard to the training issues cited above. Additionally, this report describes related, concurrent efforts to develop a training needs - technology matching procedure and apply it to Phase I findings.

II. RESEARCH METHODOLOGY

A. Data Collection

The data collection for this research effort was conducted in two general stages: first, informational interviews were conducted at the headquarters level and, then, structured interviews were conducted at the base level. Figure 2 presents the general sampling scheme for identifying relevant sources of information required to support this task.

Training personnel at the headquarters level were interviewedfor information relevant to training issues, for background information gathering, and instrument development purposes. These sources are identified in Figure 2 as being a part of the "Collateral" data collection. A list of the specific offices contacted in this stage is contained in Appendix B. Archival data (e.g., manning documents, training records, IG reports) and reference documents (e.g., regulations, briefings, talking papers) were collected from these sources as appropriate.

The actual field data collection took place at three Pacific Air Force (PACAF) bases: Kunsan AB, Korea; Osan AB, Korea; and Misawa AB,Japan. Group and individual interviews were conducted over a three week period from 27 August to 14 September, 1990 (Table 1). This series of interviews is referenced in Figure 2 as "Primary" data collection. Interviewers were two officers from the AL/HRTE and two researchers from UES, each of whom had been involved in the initial information gathering and instrument development activities.

All data from the maintenance portion of the first phase of the SLT research initiative have been collected and analyzed. The following section provides details related to the conduct of field interviews, preparation of the data, and analysis approaches.

Subjects

Data collection focused on the three primary maintenance units comprising the Combat Oriented Maintenance Organization (COMO) of PACAF: Component Repair Squadron (CRS), Aircraft Generation Squadron (AGS), and Equipment Maintenance Squadron (EMS). Messages were sent by the AL/HR to a point-of-contact in the Training Management Division (TMD) at each base several weeks prior to arrival of the interview team. Messages requested that individuals with direct experience in one or more of the three general training functions be scheduled for interviews (i.e., Planning/Programming, Management/Evaluation, Development/Delivery). Suggested personnel included: TMD (i.e., MA, MAT), Quality Control (MAQ), squadron supervisors, squadron/shop training monitor, supervisors/OJT trainers, mechanics/specialists, base OJT, and Field Training Detachment (FTD) supervisors/instructors. Additionally, several enlisted specialties were identified as being desired candidates for interviewing (i.e., Air Force Specialty Codes [AFSCs] 454X1, 324X0, 452X4, 461X0). Data were collected from 22 enlisted specialties and Air Force Engineering and Technical Services (AFETS) civilians. (Data collection also included two officer specialties, but this was considered incidental to the major data collection effort). Table 2 displays the sample demographics.

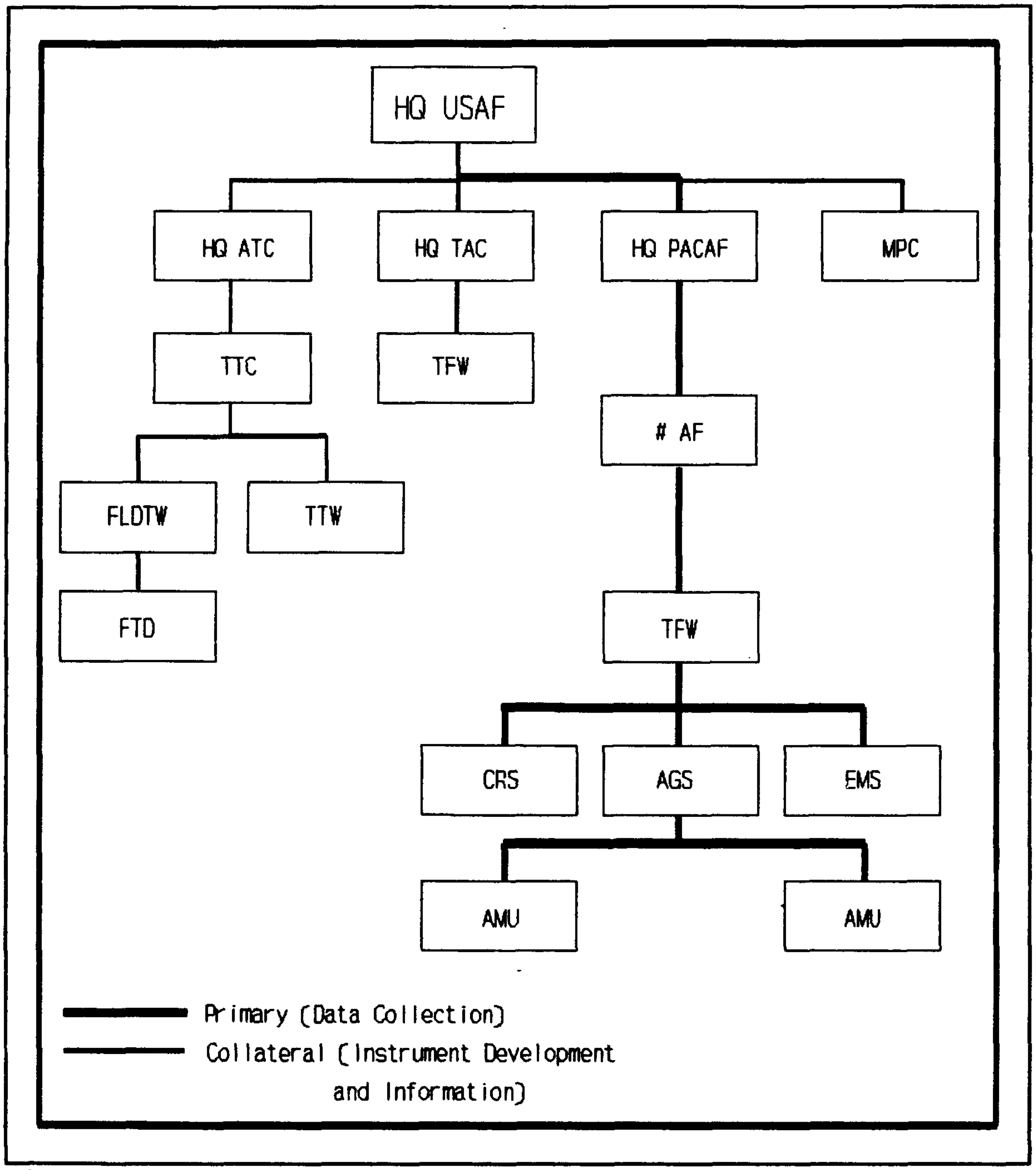

Figure 2. Data Collection Plan.

Table 1

Participation by Data Collection Site

	Number of Interview Participants					
Base	Group Sessions	(N)	Individual Sessions	(N)	Total by Sessions	(N)
Misawa	33	(107)	14	(14)	47	(121)
Kunsan	9	(23)	40	(40)	49	(63)
Osan	11	(31)	19	(19)	30	(50)
	53	(161)	73	(73)	126	(234)

Total Sessions = 126
Total Participants (N) = 234

Interview Protocol

A comprehensive interview protocol was developed for use in this project (Appendix C). The survey was designed to be applicable across all training functions with independent sections focused on the operational perspective as well as the areas of Planning/Programming, Management/Evaluation, and Development/Delivery. Thus, the interview protocol could be tailored for each interviewee dependent on their role in the training process. The survey consisted primarily of open-ended and Yes/No questions, although rating scales were included in portions of the survey (e.g., task criticality ratings, evaluations).

Procedure

All participants were given a brief introduction to the SLT project that described the purposes of the study and their personalinvolvement. Then, participants completed a brief demographic sheet; requested information included grade, current AFSC, current position, length of time in unit and position, total maintenance time, total F-16 maintenance time, current role in unit training process, major command (MAJCOM), base, and unit.

All interviews were conducted using the survey as a framework, although deviations were made as needed to accommodate time considerations, extent of interviewees' involvement in the training process, responsiveness of the interviewees, and so on. Interview sessions typically required 90 minutes, although some ran longer and others were cut short of completion due to mission demands or scheduling problems.

B. Analysis

Types of Data

Three major types of data were included in the analyses: (a) interviewee demographic data, (b) coded responses to interview questions, and (c) interview comments which were not deemed suitable for coding. All of these contributed to the analysis phase of this project. Additionally, documents (e.g., training regulations, briefing slides, talking papers) and archival data (e.g., manning documents, Training Quality Reports [TQRs], inspection reports, OJT training records and status reports) served as background resources and reference materials for analysts.

Data Preparation and Analysis

Interviewers' notes served as the basis for all content analyses. Upon completion of all interviews and return from data collection travel, these notes were transcribed to enhance readability and thoroughness. These were later reviewed and coding schemes were developed to capture the variety of responses to questions. Upon finalization of coding schemes, the interview notes were re-read and codes were assigned to each item as appropriate. More detail on this process is given below.

Content Analyses. Relevant Air Force training needs analysis research projects were identified and reviewed for details on the qualitative analyses employed (e.g., Bruce, Rockway, & Povenmire, 1989; Carson, Chambers, Gosc, 1984; Johnson, Damewood, & Phelps, 1987; Wilson & Comander, 1989). These reports give little or no information about analysis techniques used for evaluation and summarization of open-ended interview data. Other sources, however, provided guidance for the qualitative analyses.

Content analysis is, by definition, "The systematic assessment of the manifest content of communications. The assessment involves standardized procedures for the analysis of written, oral, musical, or gestural communications. Content analyses are useful for research if for some reason it is impossible to obtain opportunities for direct observations" (Yaremko, Harari, Harrison, & Lynn, 1982, p. 40). Since it was not feasible for researchers in Phase I of the SLT research study to gather information through direct observation of training, the collection of data through the use of interview protocols and archival research was appropriate, and content analysis is a suitable evaluation and summarization approach.

Table 2

Sample Demographic Data

Category	Frequency	(% of Total)
UNIT		
AGS	51	(22%)
CRS	70	(30%)
EMS	82	(35%)
FTD	4	(2%)
MA	3	(1%)
MAT	16	(7%)
QA	4	(2%)
Wing	4	(2%)
GRADE		
E1	9	(4%)
E2	20	(9%)
E3	8	(8%)
E4	35	(15%)
E5	75	(32%)
E6	39	(17%)
E7	28	(12%)
E9	1	(<1%)
03	1	(<1%)
04	3	(1%)
AFETS	5	(2%)
CURRENT TRAINING ROLE		
FTD Instructor	4	(2%)
MAT Instructor	6	(3%)
MAT Training Manager	5	(2%)
ISD Technician	2	(1%)
Squadron Training Monitor	6	(3%)
Squadron Commander/Supervisor	35	(15%)
Training Coordinator	24	(10%)
OJT Trainer	57	(24%)
OJT Trainee	39	(17%)
AFETS	5	(2%)
MAT Supervisor	6	(3%)
Base OJT	2	(1%)
None of the Above	43	(18%)

(Table 2 Cont.)

Category		Frequency	(% of Total)
	CURRENT AFSC		
	Civilian		
AFETS		5	(2%)
	Officer		
4016	Maintenance Staff Officer	3	(1%)
4024	Aircraft Maintenance Officer	1	(<1%)
	Enlisted		
324X0	Precision Measurement Equipment Laboratory	9	(4%)
45XXXa	Manned Aerospace Maintenance	3	(1%)
452X2	Avionics Systems (F-16)	18	(8%)
452X4	Crew Chief	33	(14%)
452X5	Tactical Electronic & Environmental Systems	11	(5%)
452XXa	Avionics Systems	2	(<1%)
454X0	Jet Engine	18	(8%)
454X1	Aerospace Ground Equipment	16	(7%)
454X2	Aircrew Egress Systems	8	(3%)
454X3	Aircraft Fuel Systems	7	(3%)
454X4	Aircraft Pneudraulic Systems	3	(1%)
454X5	Strategic Electronic & Environmental Systems	1	(<1%)
455X0	Photo & Sensors Maintenance	4	(2%)
455X5	Avionics Support Equipment	1	(<1%)
456X1	Electronic Warfare Systems	10	(4%)
458X0	Aircraft Metals Technology	4	(2%)
458X1	Nondestructive Inspection	2	(1%)
458X2	Aircraft Structural Maintenance	12	(5%)
458XXa	Aircraft Maintenance	1	(<1%)
461X0	Munitions Systems	19	(8%)
462X0	Aircraft Armament Systems	30	(13%)
751X0	Education	1	(<1%)
751X1	Training Systems	10	(4%)
751XXa	Education and Training	2	(<1%)

[a] Incomplete specialty code provided by participants.

(Table 2 Cont.)

<u>Tenure of Participants (in Months)</u>

	Mean	SD	Range	Median
Time in Unit	14.6	12.9	1-72	10
Time in Position	12.0	11.1	1-72	9
Total Maintenance Time	101.6	75.1	0-374	96
F-16 Maintenance Time	33.6	34.1	0-180	21

Pfaffenberger (1988) described three activities required in qualitative analysis. Each of these were accomplished during the SLT research analysis phase and are briefly noted here.

1. Rewriting. The fast pace of most field interviews requires that interviewers review their notes and rewrite findings in more detail. Pfaffenberger (1988) cited that the retrospective rewriting of notes is an integral part of field research which does more than stimulate memory and stated that "Such acts of rewriting are an important form of data analysis and theoretical discovery in themselves" (p. 26). This recapture of information helps researchers to provide the context the information which may be missing from that actual statements made by interviewees.
2. Coding. This activity is the process of attaching category names or labels to the basic units of field research data, in this case, responses to open-ended survey questions. The development of categories is an on-going process with modifications occurring as needed to best describe the responses. Pfaffenberger (1988) listed four relevant strategies for coding SLT data: (a) let coding categories emerge from the data; (b) develop general, abstract categories that fit the data; (c) classify data and develop typologies; and (d) change and refine the categories as understanding improves. The first and last of these approaches were used by analysts for this project.
3. Comparison. In this stage of analysis, the responses are analyzed in accordance with the associated categories; responses can be tallied and quantitatively analyzed. In this manner, consistent remarks among interviewees can be recorded according to a coding scheme. For those questions to which responses cannot be coded, content can be compared across interviewees for unique individual contributions or general agreement.

Responses to SLT interview questions were reviewed by analysts and, where possible, coding schemes were developed and employed to comprehensively categorize and quantify classes of responses. As an example of the comprehensiveness of this effort, 71 different types of training were noted by interviewees and coded by analysts. In this manner, the open-ended responses were labeled and tallied for quantified analysis described below (e.g., descriptive statistics).

Phase I Analyses. The content analysis efforts during this phase of research were aimed at identifying "the manifest content" of the interview data. The training issues central to this research effort formed the basic structure for the analysis. They included: 1) discerning important trends in unit-level training requirements; 2) evaluating current unit training capabilities; 3) identifying factors facilitating or impeding training; and, 4) identifying training system needs and opportunities for technology application. Particular attention was paid to these issues as they related to the instructional system development process, from the analysis of job and training requirements to the development, delivery, and evaluation of training.

As mentioned above, coding schemes were developed for as many of the interview items deemed appropriate. After coding of all interviews had been accomplished, the demographic data and item responses were entered into a database consisting of one record per participant. Each case was entered twice and compared for 100 percent verification of accuracy.

Frequency analyses were conducted on categorical response items and demographics questions. Descriptive statistics (e.g., mean, standard deviation, mode, range) were conducted on all continuous data fields. Where appropriate, the sample was divided into groups according to one or more demographic variables (e.g., unit, AFSC) to allow for examination of responses across groups.

As will be noted in the results discussed in the following sections, missing data and/or interviewee failures to give responses were frequent occurrences in this study, thereby restricting the sample size for most analyses. A number of reasons can be given for this. In many instances, for example, an individual was not asked a particular question dependent on their responses to another question. Thus, these are not "missing," but rather, "not appropriate." Also, interviewees may have been unresponsive due to factors such as apathy or non-applicability. Other primary causes of missing data were incomplete interview sessions because of scheduling problems, interruptions due to mission activity or natural disasters (i.e., flooding at Osan AB), and omissions by the interviewer. Consequently, quantitative results should be interpreted cautiously due to the "missing data." For each set of results presented here, the total number of respondents is noted.

As shown in Table 1, 73 individual and 53 group interviews were conducted. For data analysis purposes, the comments of each group interview were aggregated and counted as a single response. Thus, a group of three is represented by a single data point, a group of five is counted as a single data point, and so on. In this manner, the group and individual interviews were counted equally in the descriptive statistics. In the analyses and reporting of interview responses, the total sample size was 126 (i.e., 73 individuals and 53 groups). Demographic data were, however, collected from each participant and the figures reported in Table 2 reflect the entire sample of personnel interviewed (N = 234).

III. TRAINING ISSUES

This chapter discusses the apparent trends in current training requirements, current training capabilities, and factors facilitating or impeding the training system in general. The final section in this chapter briefly summarizes the major training problems which have surfaced during our analyses of training issues.

It should be noted that these results represent the subjective conclusions of our analysts based on an analysis of interview content and related archival data. They were based on data collected at F-16 maintenance units in PACAF and, therefore, should be interpreted as such. Appendix D contains summary tables which support the discussion of the training issues; these are referenced here as appropriate. Subsequent chapters address potential application of training technologies for the effective resolution of these issues.

A. Trends in Current Training Requirements

Air Force Manual 50-2 (1986) defines training requirements as "... those skills and knowledges which are required for satisfying the job performance requirements, and not already in the students' incoming repertoire" (p. 77). By definition, a training requirement exists when a deficit exists between an individual's acquired skills and knowledges and the job performance requirements. The findings of Phase I indicate there are at least three significant and consistent drivers of training requirements in the maintenance communities of the three bases sampled. Training requirements tend to be driven most frequently by: (a) experience levels, (b) technology, and (c) specialty restructuring through Rivet Workforce. The following sections will be devoted to an examination of these drivers and trends. Due to the wide variety of responses, no attempts will made to define AFSC-specific requirements.

Experience Levels and Training Requirements

Identification of prior experience and training in the weapon system is a precursor to determining training requirements. Data analyses indicate that 91% (68 of 75) of the maintenance supervisors interviewed determined adequacy of experience by conducting an initial interview with all new arrivals (Appendix D, Table D-1). The interview generally consisted of a review and discussion of the individual's documented job experience and training. Over-the-shoulder evaluations on selected tasks were also performed by 35% (26 of 75) of the supervisors as a part of this experience assessment process. A training requirement generally exists when the supervisor detects a skill and/or knowledge deficit.

When asked about the current trends in experience levels of maintainers, 52% (60 of 115) of the respondents felt experience levels were on the decline (Appendix D, Table D-2). Lack of experience of incoming personnel was identified by interviewees as the most significant driver of training requirements. All newly assigned maintainers in PACAF were required by PACAF Regulation 50-17 (1989) to receive specific maintenance training upon arrival at the unit (e.g., general maintenance orientation which focuses on local policies, procedures, requirements, conditions, and so on). Only those lacking adequate or current job-related experience (i.e., have not worked on the systems in the last five years) normally required additional skill training before they were permitted to perform unsupervised and unassisted tasks.

Interview findings revealed that the primary sources of experience-driven training requirements were newly assigned technical school graduates and maintainers assigned from other weapon systems. Of the 50 interviewees who identified factors contributing to a perceived decline in experience, 29 (58%) blamed turnover for the decline (i.e., experienced maintainers leaving and being replaced by inexperienced people), while 15 (30%) specified too much cross-command/weapon system movement as the culprit.

Although many (37%, 42 of 115) of the supervisors and trainers interviewed believed technical schools were generally doing an adequate job of training, they contended 3-skill levels lacked some basic maintenance skills (e.g., hands-on experience) and required extensive training before they were productive on the job (Appendix D, Table D-3). Likewise, maintainers with experience in other systems also required training to become familiar with the systems in use at the unit. However, the amount of training is significantly less than that required for 3-skill level personnel because the experienced maintainer (i.e., 5- or 7-skill level) has usually acquired skills which were readily transferrable to the new system. Table 3 presents data from 6 AFSCs on the time required for 3-skill levels upgrading to 5-skill level and time for newly assigned experienced maintainers to become position qualified. Note that the incoming 3-skill level personnel required a considerable amount of time to become position-qualified compared to those with appropriate experience. The impact of lack of experience on incoming personnel at short tour assignments is discussed later in this section.

Technology and Training Requirements

Technological advances in operational systems have been both beneficial and problematic for the maintenance community. System sophistication, in addition to creating weapon systems with increased probabilities for mission success and increased survivability, has improved system maintainability. Many of the systems on the F-16, for example, consist of modular, "black box" technologies. In addition, many systems are now self-diagnostic such that the system identifies malfunctioning components. For the maintenance technician, those features translate to less labor-intensive routine maintenance as well as rapid, relatively easy identification and repair of system malfunctions. Because of this sophistication, much of the maintenance on state-of-the-art equipment has been reduced to simple removal and replacement of components which are sent to the repair shop or thrown away.

Table 3

Average Time (in Months) Reported for Incoming Personnel to Become Position Qualified

	3-Skill Level			Experienced			T-Test		
AFS	Mean	SD	N	Mean	SD	N	t	df	p
452X2 (Avionics)	11.0	1.0	3	3.0	2.8	2	-	-	-
452X4 (Crew Chief)	8.8	2.9	10	4.3	3.5	8	3.0	5	.031
454X0 (Jet Engine)	8.8	2.6	5	4.7	1.5	3	7.0	1	.090
454X1 (AGE)	9.6	3.3	5	0.3	0.8	6	6.8	4	.002
461X0 (Munitions)	7.7	2.4	6	1.4	1.1	5	6.2	4	.003
462X0 (Armament)	9.2	3.0	10	4.4	1.7	5	3.0	4	.040
Entire Sample	9.1	2.8	71	3.6	2.9	48	11.0	37	.000

Note. Paired t-test procedure reduced sample to 1 case for AFS 452X2, preventing statistical analysis.

Although technological advancement has been largely beneficial for maintenance activities, it has also created some unique challenges in the area of maintenance training. For example, while increased reliability of equipment reduces some of the maintenance requirements (e.g., increased mean time between failure), it limits the opportunity for OJT of certain tasks on actual equipment. Because of the heavy reliance on hands-on OJT throughout the maintenance community and the generally accepted policy of not "breaking" equipment just to train, the opportunity to train on actual equipment decreases as the reliability of systems increases.

Regardless of whether the maintainers' job becomes simpler or more complex, from a training perspective, changes in technology usually mean additional or new training requirements. New terms, different procedures, and specialized equipment and tools must be learned.

Rivet Workforce and Training Requirements

Rivet Workforce (RWF) is the designation for an Air Force-wide initiative to restructure aircraft maintenance specialties. The objective of RWF is to create a more flexible maintenance force by broadening the skills, knowledge, and experience of aircraft maintenance personnel in selected specialties. Typically, RWF combined two or more specialties into one specialty, or it eliminated specialization within a specialty (i.e., shredouts). Implementation of RWF initiated a period of dramatically increased training requirements in those specialties affected by the program. During this transition period, all affected maintainers receive training and must become qualified to perform the additional tasks in their new specialty. This transition process has been called "rivetization" by the maintenance community.

Perhaps the best example of the impact of RWF on training requirements identified during SLT data collection was in the new F-16 Tactical Aircraft Maintenance specialty (AFSC 452X4B). Maintainers from three separate specialties (i.e., crew chief, flightline jet engine, and hydraulics) were combined into the one specialty. The "rivetization" of maintainers in AFSC 452X4B created additional training requirements in formal training as well as OJT. In essence, each person in the new AFSC must have acquired all of the required skills of the other two specialties. Rivetization has been particularly problematic at the data collection sites where training capability and resources, including time, are extremely limited. This situation was further aggravated by the fact that the training requirements themselves were unclear. The MAT at Kunsan AB was constructing their own Job Qualification Standards (JQSs) and training requirements lists because of this. RWF was also cited as a factor in the decline in the experience levels of maintenance personnel because it has diluted experience levels in some specialties (e.g., AFSC 452X4B [F-16 Tactical Aircraft

Maintenance], AFSC 452X5 [Tactical Electrical and Environmental Systems]) (Appendix D, Table D-2). According to some technicians, RWF reduced the credibility of Quality Assurance (QA) evaluations because QA personnel had to evaluate rivetized tasks with which they were not entirely familiar.

B. Evaluation of Current Training Capabilities

PACAF aircraft maintenance training relies on an extensive, multi-faceted approach. Virtually every enlisted maintainer, regardless of rank, skill level, or experience, receives job-related task or ancillary training as a result of his/her assignment to the command. The key elements of the PACAF aircraft maintenance training program are (a) enroute training, (b) the Aircraft Maintenance Qualification Program (AMQP), and (c) OJT. This section will first discuss the contribution of each of these training settings to PACAF squadron-level maintenance training, and subsequently, focus on the resources which were available to support each aspect of this training system (i.e., planning, programming, management, evaluation, development and delivery). Refer to Figure 1 for a depiction of the current training structure.

The objective of the PACAF aircraft maintenance program is "to develop and apply cost effective training which teaches job essential skills and knowledge" (PACAFR 50-17, 1989). Additionally, because many of the assignments in PACAF are short tour (i.e., 12 months), the command goal is to provide as much required mission-essential technical and ancillary training as possible prior to an individual's arrival at the unit. A total of 2961 enlisted maintenance personnel in the 45 (Manned Aerospace Maintenance) and 46 (Munitions and Weapons) functional communities were assigned to the maintenance complexes of the three data collection bases. This number approximates the annual trained personnel requirement (TPR) for those bases. The training programs discussed here must possess the capability to train on an annual basis the vast majority of these personnel since most will be reassigned each year.

Training Settings

Enroute Training. Enroute training occurs in conjunction with a permanent change of station (PCS) assignment, but prior to arrival at the new duty station. It is intended to ensure that maintenance personnel arrive at their units with the mission-essential skills needed to be immediately productive. Enroute training is especially critical for those who lack experience in the systems they will maintain at their new assignment. Technical school graduates, personnel from other commands, and maintainers who lack recent experience in the system (i.e., within the last five years) are those for whom enroute training was designed.

Enroute training requirements are identified through a coordinated effort between the personnel, maintenance, training, and operational activities involved in assignment of the maintainer to PACAF. When an individual is selected for assignment to a PACAF unit, appropriate notifications are routed to the gaining unit through the personnel and maintenance staffs at both HQ PACAF and the base. The gaining unit reviews the documented experience and training of the individual being reassigned and determines whether the individual requires enroute training to do the assigned job. If training is required, the process is essentially reversed, becoming a request to ATC to provide enroute training at an appropriate FTD. (Note. A detailed description of this process, including the office symbols of participants and administrative procedures, can be found in Chapter 5, PACAFR 50-17.) ATC's 3785th Field Training Wing, headquartered at Sheppard AFB, TX, is responsible for conducting enroute training at its FTDs.

Interview findings indicate that maintenance supervisors were becoming increasingly concerned about the number of people arriving who did not receive the needed enroute training. HQ PACAF/LGMMR staff admitted that more people were assigned without receiving enroute training than they would like to have seen. They blamed part of the problem on communications delays in the assignment notification, unit review, and training request process. Several interviewees at HQ PACAF suggested that electronic mail would greatly enhance their ability to speed up the process and ensure most, if not all, receive the required enroute training.

Lack of enroute training was of particular concern at the Korean bases because of a lack of adequate FTD; Kunsan AB has no FTD and Osan AB has only a limited FTD capability. At a remote short tour base such as Kunsan AB, if a maintenance technician doesn't receive the required formal FTD training prior to arrival, he/she will likely depart for another assignment having never received the training. PACAFR 50-17 (1989) directed formal training be provided to Korean units via Mobile Training Team (MTT) or temporary duty (TDY) FTD instructors, as well as via enroute training, although travel funds were frequently not available to support those types of training. Several interviewees suggested that developing the capability to "bring the classroom to the students" would significantly enhance unit-level training.

Aircraft Maintenance Qualification Program (AMQP). AMQP is a centralized three-phase orientation and training program designed to ensure that maintainers arrive at their unit with the skills to be immediately productive and provides structured training throughout their assignment to PACAF. A key concept in the design of AMQP is centralization of training. Recognizing that mission requirements often interfere with the unit's ability to provide effective orientation and qualification training, AMQP attempts to conduct training in an environment that is not in competition with sortie production. The Training Management Division (TMD) at each PACAF base is the primary point-of-contact and advisor to the Deputy Commander for Maintenance (DCM) on all maintenance training matters, and one of the TMD responsibilities is to manage the AMQP. PACAFR (Chapter 2) 50-17 describes the organization, responsibilities, and manpower authorizations of the TMD.

As noted earlier, the three-phase AMQP prepares maintenance personnel for the complex and critical demands of providing mission capable and safe aircraft for the training of combat crews. Phase I must be completed by all new arrivals and includes unit in-processing, initial interview/evaluation, general maintenance orientation (i.e., block training), and ancillary training. The initial interview/evaluation determines what training, if any, the individual requires subsequent to Phase I. Phase II is formal FTD training designed to provide practical training on specific systems. This training serves as a foundation for entry into Phase III and OJT. Phase III is hands-on task oriented training (TOT) on the actual equipment. Completion of Phase III signifies the individual is prepared to perform specific tasks unsupervised and unassisted. PACAF requires completion of Phase III for maintainers in AFSCs 452X4X and 462XX assigned to the flight-line. Quality Assurance (QA) personnel assigned to the DCM staff ensure the quality of training by conducting task evaluations of AMQP Phases II and III graduates and reporting the results to TMD.

<u>On-The-Job Training (OJT)</u>. OJT is the mainstay of unit-level training throughout the Air Force. Enroute training and AMQP do not replace or diminish the need for effective OJT. Although the recent revision of AFR 50-23 (1990) has changed many of the policies and procedures affecting enlisted specialty training (EST), the concept of OJT remains virtually unchanged. The establishment of self-study programs such as career development courses (CDC) as a separate component of EST is the most significant change affecting OJT (Note. Figure 1 reflects this recent change to OJT).

OJT is informal training conducted at an individual's duty location. It can include: (a) hands-on, over-the-shoulder instruction; (b) exportable courseware (e.g., interactive videodisc [IVD]); (c) unstructured self-training (e.g., observation, repeated task performance); and (d) evaluation and assessment tools used to identify individual training needs (e.g., performance evaluation checklists, written knowledge tests). Data analyses indicate hands-on training is the preferred method for conducting OJT. Of the 93 interviewees who responded to the question concerning the use of different types of instructional media/methods, all (100%) reported the use of hands-on instruction at the unit level (Table 4). Additionally, for the vast majority of interviewees, hands-on was also considered the most effective method of instruction (see Table 5).

The maintainers often expressed a need for ways and means to facilitate and enhance the conduct of OJT, and specifically hands-on skill training. When asked which features of training technologies were most desirable, the preference was for those features which aided in the training of difficult tasks such as troubleshooting and allowed for hands-on skill development. Most of the maintenance technicians recognized that hands-on training and OJT were the core of the training program at the unit level. Although respondents were often vague about how to improve OJT, a few suggestions did emerge, such as more standardization of task requirements and evaluations, less emphasis on recordkeeping, better qualification of trainers, stronger leadership support, and better feedback to training planners, managers, and developers. Most of the suggestions offered, as may be seen in the examples just given, are addressed in the discussion of other training need or problem areas. This indicates a widely-held and often expressed feeling that the key to better training at the unit level lies in the OJT program, and any effort designed to increase efficiency in unit-level training must be relevant to the OJT process.

Training Resources: Planning and Programming

The purpose of training planning and programming is to determine who, what, when, and where to train. It includes a variety of macro-level activities which must occur prior to the development and implementation of training. One of the first activities in planning and programming is the analysis of jobs and identification of those job tasks which require training. Once this has been completed, training is allocated amongst the various training settings and resources are programmed to support it.

The units visited during this project were not involved, to any significant degree, with the training planning and programming activities noted above. These functions occurred at higher levels within the AF, i.e., the MAJCOM and AF level. Their products, such as Specialty Training Standards (STS) and Job Qualification Standards (JQS), were filtered down to the field and, in turn, used by units to manage the training requirements of their personnel. Consequently, the resources for planning and programming at the unit level were very limited.

Problems did exist, however, with the planning and programming products sent down to the units. In particular, there appeared to be a lack of symmetry between the perceived training requirements and those specified in planning documents. Respondents identified a significant amount of training as being conducted to an inappropriate level (i.e., not needed, overtrained, undertrained, or needed but not available). A number of maintainers, for example, felt that some training requirements, such as Hangar/Arch Door training, Egress training, and Block training, were either not needed or overtrained. These sentiments pertained to ancillary training requirements in particular (which are predominantly taught at MAT), although examples of unnecessary job-related training were also cited. Respondents felt that some training requirements were unnecessary because they simply were not relevant to their AFSs. Some respondents also felt that they performed tasks frequently enough on the job and did not need further training.

The maintenance technicians also noted an absence or lack of training in some areas. FTD Qualification and CAMS training were the areas most frequently cited as not being trained. According to the technicians, the courses were either not offered or a qualified instructor was not available to teach them. Areas that were considered undertrained included Self-Aid and Buddy Care, Chemical Warfare, CPR, CAMS, and troubleshooting skills training. Maintainers saw these areas as critical to their jobs and, thus, deserving of more attention. This training, according to those interviewed, should ideally occur prior to arrival at a duty station (i.e., enroute). Tables D-4 to D-7 list the types of training identified as being conducted inappropriately.

The apparent asymmetry between actual and perceived training requirements concerned OJT trainers and workcenter supervisors. There was a perception that training needs assessment has not kept pace with changes in job requirements. The DCM at one of the data collection sites communicated a need to be able to accurately determine exactly what skills and knowledges are required of each job in the maintenance complex so that each incumbent could receive the appropriate training for the job. Any unnecessary training was counterproductive and debilitating, especially with the current workload and manning constraints. Nonetheless, these supervisors did not feel comfortable in making training content decisions that might impact a trainee's career progression. They were either not aware of how these decisions were made at the macro levels (i.e., Utilization and Training Workshop, OSR, Ancillary Training Review Panel) or felt those procedures were to complex to use at the workcenter level.

<u>Training Resources: Development</u>

Training development activities have typically been the responsibility of organizations such as ATC or other MAJCOMs. Training is developed using products from the planning and programming phase, such as job analyses, core task lists, and task training requirements. Development includes activities such as test development, selection of instructional media and methods, and development and validation of instructional materials.

The resources available for training development at the units in this study were minimal. The primary development tool noted by interviewees was the ISD model as presented in AFM 50-2 and AFP 50-58. However, these documents were difficult for laymen to understand and apply, and the availability of personnel with ISD expertise rapidly declined as one moved from FTD to MAT to the maintenance unit itself. In fact, very few personnel at the maintenance squadrons even knew what ISD was.

The availability of training development expertise at each location directly impacted the amount of training development actually done. This, of course, limited the ability of instructors to tailor their own training programs. Yet, despite all of this, the maintenance instructors expressed little concern over the lack of resources for training development. They were either satisfied with the courses they had or developed themselves, or they felt that development was the responsibility of others, such as ATC.

Training Resources: Delivery

The description of training capability in AFR 50-23 (1990) includes availability of resources as a primary consideration when determining a unit's capability to provide training. The key resources to consider are equipment, qualified instructors, facilities, and training materials such as study references audio-visual materials.

Equipment. A key responsibility of the TMD is to ensure theavailability of equipment resources to support TMD training (e.g.,AMQP Phases I and III), FTD training (e.g., enroute training, AMQP Phase II), and mobile training teams (MTT). TMD identifies requirements and schedules equipment, including aircraft, in the Monthly Maintenance Plan. Interviewee comments indicated equipment availability was not a significant issue for SLT.

Qualified Instructors/Unit-Level Trainers. Instructors and unit-level trainers who are subject matter competent and proficient in conducting training are critical to an effective training program. Policies and procedures are established by AFR 50-54 (1987), PACAFR 66-5 (1983), and PACAFR 50-17 (1989) to ensure availability of qualified instructors for FTD and TMD training in PACAF. Maintenance instructors (MI) are selected based upon their maintenance experience and skill as well as their motivation to teach. Both FTD and TMD are authorized permanent, full-time instructor staffs. The number of authorized positions is relative to maintenance AFSC populations at the base. FTDs and TMDs may also assign temporary MIs when training requirements warrant. In addition, each unit assigns its own personnel to act as OJT trainers for less experienced maintainers. The following discussion focuses on the primary instructor- and trainer-related problems found at the unit level.

A major problem at maintenance units was the unavailability of OJT trainers brought about by competing commitments. Deployments and exercises, in particular, often reduced the number trainers at the unit level. The importance of the operational mission during deployments and evaluations (or competition) during exercises necessitated, for the most part, that only the most qualified personnel attend. Consequently, trainers are removed from the squadron while the less experienced maintainers are left behind. At Kunsan AB, this problem was compounded because of the absence of an FTD. The FTD's training burden has shifted to the unit OJT programs, many of which are already burdened as a result of the lack of experience of incoming personnel.

FTDs also suffered from limited availability of instructors and could not meet the needs of the field. The demands of the operational units simply exceeded the number of available instructors, and therefore, many of the trainees were not receiving the training they required. When asked what limited FTD training, 56% of the respondents cited a lack of qualified instructors.

Another problem concerned the technical qualifications of OJT trainers. Some trainers, while available at the unit, lacked the technical expertise necessary to train certain tasks. Rivet Work Force has contributed to this problem by merging two or more AFSs and making trainers at the unit level, in particular, responsible for knowing and instructing tasks for which they themselves have not received sufficient training. As a result, many of the trainers are learning tasks at the same time they are attempting to instruct others on them.

Personnel turnover and shift work accounted for another OJT trainer-related problem. Because of short-tour lengths and swing shifts, trainees often had several different trainers. As a result, trainers had very little knowledge of their trainee's capabilities, experience, strengths and weaknesses. The trainers also had different styles of instruction, some good and some not so good. This situation created considerable discontinuity and impeded the training process.

Finally, quite a few OJT trainers were not trained to be instructors and lacked necessary teaching skills. While these instructors are technically competent, they are not very effective instructors. Less than a quarter of the OJT trainers interviewed received any formal course in technical instruction. A majority of the instructors and trainers in our study received no formal training at all or attended the OJT Trainer/Supervisor Course which, according to the respondents, did not adequately teach them instructional techniques.

Several OJT trainers raised an issue concerning their qualifications to train. They stated that, although they felt subject matter qualified, they received no or inadequate training on how to conduct OJT (Appendix D, Table D-9). When asked how they were trained or qualified to instruct, 8 of 22 OJT trainers (36%) responded that they received no formal training to be an OJT trainer. Several others who attended the OJT Trainer/Supervisor course at FTD felt the course did not adequately prepare them because it emphasized documentation of OJT rather than instruction.

Facilities. Training facilities did not appear to be an issue at any of the data collection bases. Both FTD and TMD have dedicated office and classroom/laboratory space at each of the data collection sites. Most of the squadrons have no dedicated classroom/laboratory space and must use unit conference rooms if training requires a classroom-type setting. Since most of the unit-level training at the work center is OJT, dedicated training facilities are neither required nor practical.

Training Materials. Availability of training materials was not an issue for most interviewees. FTD and TMD staffs developed training materials to support their courses and there was heavy reliance on technical data (e.g., technical orders [TO]) in all maintenance training. The primary concern among interviewees was that some training materials were out-of-date. Most complaints centered on videotapes used at TMD. Many of the tapes have been used to support training for years and they depict obsolete equipment and procedures. Interviewees questioned the credibility and quality of training provided by such materials. Finally, there was some concern over the lack of Career Development Courses (CDCs) for rivetized specialties.

Media/Methods. OJT tended to rely heavily on self-paced hands-on instruction supported by text (e.g., TOs, CDCs). FTD and TMD courses were typically conducted in classroom/laboratory settings, and were supported by a variety of dedicated training media, and tended to be group-lockstep or group-paced. Dedicated training media were generally not available in the units. The types of media/methods available to conduct SLT and the percent of respondents using them are contained in Table 4; ratings of the effectiveness of instructional media and methods are displayed in Table 5.

The only issue identified that involved media or methods was the lack of availability of IVD. Each of the bases visited had IVD courseware, but only one base appeared to be using it for SLT and that base was using it minimally. Although IVD application is limited because the bases had only a few tasks available for training, several TMD staff members interviewed had no guidance or training on how to integrate IVD into their training when courseware becomes available. Additionally, most of the unit-level interviewees (i.e., OJT trainers, training monitors, shop chiefs, training coordinators) were either unaware that IVD courseware was available on base or that the technology even existed.

This availability issue also reflects a potential user acceptability concern which may require further study. The problem of successfully transporting IVD to the unit highlights the need for training technology developers and programs managers to plan integration of new technologies into the user community and provide mechanisms for support. If trainers are reluctant, for whatever reason, to use an available technology such as IVD, they are likely to be just as reluctant to use other technologies. Table D-10 in Appendix D presents specific technologies and features that are desired by unit-level training personnel.

Training Resources: Management

Management, as it is used here, refers to the day-to-day management of training operations. Management activities include managing individual training requirements, scheduling students and instructional resources, and tracking student progress. Training management responsibilities are shared by the TMD and training monitors at each of the maintenance units. The units in this study had several management information sources and tools at their disposal for accomplishing these activities.

Individual Training Requirements. Management of individual training requirements involves the initial identification of training requirements and the management and tracking of those requirements thereafter. For the initial identification of individual training requirements, units relied predominantly on individual interviews, personnel training records (AF Form 623 and 797), and CAMS reports. The personnel training records and CAMS reports also served as the primary tools for managing and tracking training requirements.

Respondents reported no significant problems with the tools and procedures for tracking training requirements. They also felt comfortable with the initial evaluations of training requirements for incoming individuals. However, as noted above, training managers were uncomfortable making decisions about training requirements for individuals which deviated from those listed in the planning and programming documents, e.g., STS or AF Form 623.

Scheduling Students and Resources. The resources for scheduling both students and instructional resources were limited. The scheduling of students was accomplished using CAMS as well as correspondence between the TMD and individual units. For example, units had to submit requests for formal courses (e.g., FTD courses) to the TMD who then forwarded the request to ATC for coordination, and vice-versa. In the end, however, scheduling was reduced to last minute phone calls between schedulers and units.

Equipment scheduling was done predominantly through the Monthly Maintenance Plan. There did not seem to be a problem with this function.

Training Resources: Evaluation

Evaluations are critical to the success of an instructional program. They provide feedback to instructional designers about he effectiveness of their courses. There are two general types of evaluations, internal and external. Internal evaluations are based on student performance. They reveal the effectiveness of instruction within the instructional environment. External evaluations, on the other hand, are based on job performance and are an indication of training transfer. These evaluations also provide valuable feedback to individuals or units. They can, for example, be used to determine whether or not an individual has successfully acquired the requisite knowledges and skills in a training course, or they can be used to measure unit readiness.

Based on the data collected in this study, maintenance units had very few resources for evaluating either the internal (i.e., student performance) or external validity (i.e., job performance) of their training. Internal validity was predominantly evaluated using paper and pencil tests (for ancillary training), course critiques, and over-the-shoulder evaluations based on Technical Orders (for job-related training). The over-the-shoulder evaluations were loosely structured and often varied from individual to individual. External validity was evaluated using follow-up surveys, e.g., Training Evaluation Reports (TER), Training Quality Reports (TQR), and local questionnaires, and informal communications with units. TMDs, FTDs, and Tech Schools would typically send out surveys to graduates and their supervisors 60 to 90 days after graduation. These surveys solicited feedback on the appropriateness and effectiveness of the course. Additionally, the maintenance community used QA personnel to evaluate unit readiness, as well as AMQP graduates. These evaluations provided valuable job performance feedback to the AMQP courses, in particular, and the unit-level training system, in general.

The interviewees did not express any significant concerns over the effectiveness of training evaluation procedures with regard to student performance. They did, however, express some concern over the effectiveness of procedures for evaluating the external validity of training. For example, several maintainers had doubts about the effectiveness of the follow-up surveys. They felt that these surveys failed to communicate training requirements back to the training community.

Many of the interviewees also felt that the Quality Assurance (QA) evaluations were both not standardized and poorly planned, and consequently, needed improvement. According to these individuals, the evaluations were not consistent across evaluators. Different raters would evaluate the same task using different criteria. Also, these evaluations were seemingly performed on the same sets of individuals each time. Personnel on swing shifts, for example, were rarely evaluated. Finally, many of the interviewees (including QA personnel themselves) felt that QA personnel often lacked the technical competence needed to evaluate many of the job tasks. This problem was largely due to the additional requirements imposed on QA personnel by Rivet Workforce. Many of them had only recently learned, or were in the process of learning, new sets of tasks which they were required to evaluate.

Table 4

Frequency of Use of Instructional Media/Methods

Instructional Media/Method	% of Respondents Using Media/Method For Unit Level Training
Lecture/Presentation	84.2
Overhead	67.4
CAI	10.5
Sound-on-Slide	56.8
Video Tape	78.9
IVD	12.6
Text	97.9
Hands-On	100.0
Mockup	5.3

Table 5

Ratings on the Effectiveness of Instructional Media/Methods

Instructional Media/Method	Mean Effectiveness (1-7 Scale)		
	Mean	SD	N
Lecture/Presentation	5.2	1.4	83
Overhead	4.4	1.4	71
CAI	4.5	2.1	15
Sound-on-Slide	4.3	1.5	57
Video Tape	5.3	1.3	77
IVD	5.2	1.6	14
Text	5.7	1.3	91
Hands-On	6.7	.7	94
Mockup	7.0	0.0	4

Note. Scale values for effectiveness ranged from 1 (Very Ineffective) to 7 (Very Effective).

C. Factors Impeding or Facilitating Training

This section focuses on identification of factors which either limit or enhance unit level training beyond those factors directly related to training requirements or training capabilities. The ability to train effectively and efficiently is determined by a wide variety of external factors such as the time available to conduct training, competition for available resources, organizational structure, and so forth. Altering any of these factors can conceivably change the effectiveness and efficiency of training. One goal of the SLT Research Initiative is to identify those HSD technologies which best enhance facilitating factors or reduce impeding factors.

Impeding Factors

Availability of Time. Lack of adequate time to train was a major issue for interviewees. When asked if there was adequate time available for training, 42% (47 of 111) responded that there was not sufficient time available to train at the unit. Only 12% (9 of 74) and 3% (3 of 105) stated there was not sufficient time available to train at FTD and TMD respectively. Of the 47 interviewees who denied having enough time to train at the unit, 40 (85%) identified mission requirements/operational commitments. Lack of emphasis on training (10 of 47, 21%), non-availability of trainers/trainees due to TDY, leave, details, and so on (8 of 47, 17%), and decreased manning levels (7 of 47, 15%) were also identified as time limiting factors (Appendix D, Table D-11).

The great difference in training time available at the unit versus both FTD and TMD was due to the emphasis placed on meeting FTD and TMD training requirements and mission requirements. PACAFR 50-17 (1989) assigns the TMD responsibility for scheduling unit personnel for FTD and TMD training. The regulation directs unit commanders to ensure their personnel attend training. The regulation also prescribes the policy that, while unit personnel are in scheduled training, "FTD and AMQP training must be given priority and will not be canceled when local exercises are conducted" (p. 4). As a result of this emphasis on completion of training outside of the unit, supervisors and trainers "make time" for FTD and TMD training, but, mission requirements generally impeded their ability to devote enough time to training at the unit.

OJT tended to suffer the most under these conditions. Several interviewees admitted that, due to the flying schedules, there was little time for unit-level training in those AFSCs which directly supported launch and recovery of aircraft. One senior officer expressed deep concern for the lack of opportunity to conduct maintenance training and stated a strong case for "... either biting the bullet and flying less or scheduling the flying differently." This sentiment was echoed by other officers and NCOs at various levels within the maintenance management community.

Manning and Personnel Policies. Manning and personnel policies combine to impede the ability to provide adequate training, particularly at short tour bases. All of the PACAF bases visited, including HQ PACAF, were reducing manning levels to 85% of authorized strength. Some units reported manning levels below 85% during the data collection period. There also appeared to be an increase in the number of new arrivals with little or no experience with F-16 maintenance. The resulting situation was one in which training requirements were increasing as the ability to conduct traditional training is decreasing. Most of the interviewees at each base recognized this as a significant issue. When asked for proposed alternatives to this problem, 69% of those responding (24 of 35) recommended that the personnel assignment policies should be changed to reduce the number of new arrivals who lack experience in the weapons system (e.g., technical school graduates, cross-command/weapon system re-assignments) (Appendix D, Table D-2). Specifically, they recommended assigning maintainers to short tour bases according to special experience identifiers (SEI) as well as skill level so that only personnel with appropriate weapon system experience would be assigned, reducing the need for basic systems training. They were particularly adamant about not assigning 3-levels to short tour areas because they are minimally productive and do not receive adequate training. As one NCO stated, "By the time we get them trained, if we get them trained at all, they are ready to leave" (refer to Table 3). There is also genuine concern on the part of supervisors, trainers, and trainees that the training most 3-levels receive at short tour bases puts them at a distinct disadvantage with regard to career progression when compared to their contemporaries assigned to long tour overseas or continental U.S. (CONUS) bases. Specific effects of personnel turnover cited by participants are listed in Table D-12 (Appendix D).

Lack of Funding. An obvious constraint in today's environment is the budget. Although budget cutbacks can be associated with a number of training problems, one problem in particular stands out in this analysis -- the lack of TDY funds. This situation has greatly restricted access to qualified instructors. Kunsan AB, as noted earlier, has no FTD and, therefore, FTD instructors from other bases must travel to Kunsan AB to conduct training. Unfortunately, interviewees contended that the travel funds were not readily available to bring instructors from other bases nor send individuals from Kunsan AB TDY to be trained at an FTD. As a result, much of the qualification and continuation training was not accomplished or the quality of training suffers. The non-availability of qualified instructors at Kunsan AB illustrated the importance of enroute training.

Facilitating Factors

Attitude and Motivation. Not enough can be said about the positive attitude and motivation of the aircraft maintenance community. They have been "doing more with less" for so long that it has become almost routine for them to overcome adversity. This was particularly true at the SLT data collection sites. Regardless of the impediments to conducting training, supervisors and trainers seemed to always find a way to both get the job done and to train their people. Motivated trainers and students willing to learn keep the training programs moving forward.

Changes to OJT. As noted earlier, AFR 50-23 (1990) was recently revised resulting in substantial changes to EST which should facilitate training significantly. Some of the structure has been removed from the program and some regulatory requirements have been changed which should permit more flexibility in planning, developing, conducting, managing, and evaluating unit-level training. Many of the details of EST were purposely left to the people in the training system who best understand unit-level training and can best determine specific training needs. Perhaps the most beneficial change in EST was to put more emphasis on evaluation of job performance rather than paperwork to determine effectiveness of training. In addition, added emphasis has been placed on preparing OJT trainers to plan, develop, deliver, and evaluate training.

Increased Commitment to Maintenance Training. There appears to be a growing commitment at various levels within the Air Force to providing the best training possible, particularly for the maintenance community. This research initiative is partial evidence of that commitment. Faced with reductions in manning and budget cuts, senior officials are relying on enhanced training to ensure that mission requirements are met.

D. Summary of Major Training Problems

Table 6 summarizes the apparent deficits or problems in training for PACAF F-16 maintenance units as seen in the analysis of unit level training requirements, training capabilities, and those factors influencing SLT. Each of the issues listed in Table 6 is discussed more fully in the preceding sections of this chapter. These deficits are indicative of specific areas within the training system which may potentially benefit from technology applications. For example, the problem of Inappropriate Training Requirements may indicate a poor training requirements selection process and/or poor management of individual training requirements. These issues will be discussed more fully in the next chapter.

Table 6.

Summary of Major Training Problems For PACAF F-16 Maintenance Squadrons

1. Inappropriate Training Requirements (e.g., Lack of Troubleshooting, Basic Systems Knowledge, and Computer Training)
2. Lack Of Qualified Instructors/OJT Trainers
3. Manpower and Personnel Policies (e.g., Rivet Workforce, Cross-Command/Weapon System Assignments, Manning)
4. Need For Enhanced Hands-On Training/OJT
5. Lack of Training Opportunities Due To Improved Weapon System Technology
6. Limited Training Time Due To Operational Commitments
7. Lack of Enroute Training
8. Inadequate Feedback Mechanisms For Training Courses
9. Inadequate Job Performance Measurement Procedures
10. Lack of TDY Funding
11. Implementation Problems With New Training Media

IV. RELATING TRAINING SYSTEM NEEDS TO TRAINING TECHNOLOGIES

This chapter describes the process by which the needs of the unit-level training system were systematically identified, documented and matched to HSD training technologies. In the previous chapter, researchers identified a number of general problems in the unit-level training system for PACAF F-16 maintenance units. Researchers described these problems with broad narrative statements based on the results of their content analyses. However, these broadly-defined problems, while insightful in and of themselves, required further analysis before they could be related to training technologies. This chapter documents the efforts of researchers to identify the specific training system functions implicated by these problem descriptions as being deficient, and subsequently, to relate them to the functions of HSD training technologies.

The impetus for this line of Air Force research lies in the certainty that force structure and budgetary levels will continue the trend of systematic reductions and short-term adjustments to immediate fiscal shortfalls. This activity constitutes an intermediate step in the development of a long-range S&T Investment Strategy with the establishment of a framework with which to focus the emerging technologies against concrete user needs. Matching of training needs and technologies is only a preliminary step, however, since this phase of the research initiative examined only a narrow segment of the Air Force training domain (i.e., F-16 aircraft maintenance units deployed in the Pacific theater). Accordingly, suggestions will be made for further research that will attempt to generalize the results of this data collection across a larger segment of the Air Force's vast training system.

A. Analytic Framework: ISD Model

A review of available training literature and AF training research revealed that no clear-cut or systematic methodologies existed for identifying, documenting and relating training system needs to training technologies (Carson, Chambers & Gosc, 1984; Chenzoff et al., 1984; Stephenson & Burkett, 1975). Most of the research in this area has focused on training needs assessment and has not attempted to identify and relate the needs of the training system to potential technology solutions.

This study adopted a "training system needs assessment" approach as opposed to a traditional training needs assessment approach. The distinction between the two is important here. On the one hand, a training needs assessment "provides information on where training is needed, what the content of the training should be, and who within the organization needs training in certain kinds of skills and knowledge (Ostroff & Ford, 1989)." This type of assessment stresses the importance of three interrelated components: organization, task, and person. A training system needs assessment, on the other hand, provides information on which processes or functions in the training system need improvement. These processes can be broadly stated as planning, programming, management, evaluation, development and delivery of training. Consequently, training needs assessment would be one process within this system.

The basic analytic framework chosen for this research was the Instructional System Development (ISD) model. This model had several features which made it appropriate for this purpose. First, the ISD model covered a wide range of training activities, including planning, programming, development, delivery, management, and evaluation. Moreover, the model can be defined at such a level as to differentiate between the unique functions of various training technologies. Many technologies, while somewhat similar, are intended to enhance different aspects of the same general training area. For example, two technologies might enhance training management but do so in qualitatively different areas, such as resource scheduling and student tracking. A broadly defined framework would not capture these nuances. Fortunately, the ISD model allowed us to describe training technologies and research at a meaningful and analytically useful level.

The ISD model is also widely accepted within the AF and other training communities, although the exact form of this model is a matter of continuing debate. AFM 50-2 and AFP 50-58, in particular, formed the basis of the framework. The final version, as seen in figure 3, was the result of repeated reviews and modifications by AL/HRT ISD experts. Each of the processes is defined in Appendix F.

B. Applying the Analytic Framework

The process of matching training technologies to training system needs occured in three steps. In the first step, researchers developed profiles for a selected group of training technologies based on the analytic framework shown in figure 3. The "technology profiles" contained the specific ISD processes (i.e., training functions) which were enhanced by a technology. Next, researchers examined the general training system problems identified during analysis of the interview data to determine the specific ISD processes which needed improvement. As such, the "training system problem profiles" contained the specific ISD processes which needed improvement according to the researcher's interpretation of the general problem description. In the final step, the technology profiles were compared to the training system problem profiles, and areas of overlap and non-overlap were noted. Following is a discussion of the procedures and results of this matching process.

Figure 3. **Analytic Framework Based On Instructional System Development Model**

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES								
ANALYZE SYSTEM REQUIREMENTS	TRNG NEEDS ASSESSMENT								
	analyze situation								
	identify parameters								
	DEFINE/ANALYZE JOB PERFORMANCE RQTS								
	develop task listing								
	analyze job tasks								
	est. target pop characteristics								
DEFINE EDUCATION & TRAINING RQTS	SELECT TASKS REQUIRING TRNG								
	DETERMINE STUDENT PREREQUISITES								
	SELECT APPROPRIATE TRNG SETTING								
	FORECAST RESOURCE/LOGISTIC RQTS								
DEVELOP OBJECTIVES & TESTS	DEVELOP OBJECTIVES								
	DEVELOP TESTS								
	DEVELOP JOB PERF TESTING METHODS								

Note. Adapted from AF Manual 50-2 and AF Pamphlet 50-58

(Figure 3 continued)

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES								
PLAN, DEVELOP & VALIDATE INSTRUCTION	PLAN SEQUENCE OF INSTRUCTION								
	SELECT INSTRUCTIONAL METHOD								
	eval alternative instr methods								
	select instructional method								
	establish detailed course design								
	SELECT INSTRUCTIONAL MEDIA								
	evaluate candidate media								
	select instructional media								
	develop system specifications								
	DETERMINE RESOURCE AND FUNDING RQTS								
	DEVELOP INSTRUCTIONAL MATERIALS								
	author instructional material								
	produce instructional material								
	VALIDATE INSTRUCTIONAL MATERIALS								
	review courseware prototype								
	individual & small group tryouts								
	VALIDATE COMPLETE SYSTEM								

(Figure 3 continued)

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES								
CONDUCT & EVALUATE	DELIVER INSTRUCTION								
	SUPPORT INSTRUCTION								
	schedule students								
	schedule resources								
	track student progress								
	manage training rqts								
	maintain & update instr system								
	EVALUATE INSTRUCTION								
	evaluate student performance								
	evaluate job performance								
	measure utility & cost-benefit								

Training Technology Profiles

HSD has a number of training technologies currently under development (Appendix E). The impetus for training technology research comes from a number of different sources including formal requests from AF organizations as well as self-initiated research in response to anticipated needs. Yet, whatever their source is, these technologies have one goal in common, to improve the effectiveness or efficiency of one or more parts of the training system. The objective of this step of the matching process was to develop a profile for each of the selected training technologies by identifying those parts of the training system which they were intended to enhance. In other words, each technology is intended to add to the knowledge or technology base of one or more of the ISD processes.

The term "training technology," as it is used here, requires some explanation. Rousseau defined technology as "a process for transforming physical and information inputs into outputs (1983, p. 225)." As such, a training technology can refer to a wide range of items, including hardware, software, research procedures, data collection instruments, and analysis tools. In this study, researchers were primarily concerned with research projects and not necessarily individual training technologies, per se. These projects may, in fact, develop and integrate several types of training technologies into one system in order to achieve a specific goal or meet a specific need. For simplicity sake, however, a project will be referred to as a training technology, whether it encompasses a single technology or a system of integrated technologies.

The most reliable sources of information about the training technologies were project managers and laboratory technical directors. These people possessed the most accurate and up-to-date knowledge about the specific projects and could identify the specific training functions that the technologies were designed to enhance. Researchers provided the laboratory technical directors who were responsible for technical training-related research with the ISD-technology matrix seen in Figure 4 and asked them to indicate below each of their technologies the specific training processes being enhanced (i.e., the knowledge or technical base of that ISD process is increased). They also received a list of definitions clarifying the function of each ISD process. The final set of profiles (Figure 4) represents the collaborative efforts of the technical directors and the project managers who oversaw the research and development of the individual technologies.

The technology profiles presented here portray the intended final form of the technologies. Since these technologies are currently under development, their profiles may or may not change with time. For example, the Advanced On-The-Job Training System (AOTS) evolved into a production ready technology, the Base Training System, which provides only a portion of the training functions of the original technology prototype. It went from

Figure 4. Profiles Cataloguing the ISD Processes Enhanced By Each Training Technology

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES	ADV INSTRUCTIONAL DESIGN ADVISOR	ADVANCED OJT SYSTEM/BTS	BASIC JOB SKILLS	CBT SELECTION ADVISOR	CODAP	FUNDAMENTAL SKILLS TRAINING	JOB-AIDED/TRNG ALLOCATION TECH	JOB PERFORMANCE MEASUREMENT	INSTRUCTIONAL SUPPORT SYSTEM	INTEGRATED MAINT INFO SYSTEM	INTEL COMP-AIDED TRNG TESTBEDS	INTELLIGENT TUTORING SYSTEMS	LOGISTICS COMMAND AND CONTROL	TRNG DECISIONS MODELING TECH	TRAINING EVALUATION
ANALYZE SYSTEM REQUIREMENTS	TRNG NEEDS ASSESSMENT															
	analyze situation						●	●								
	identify parameters				●			●						●		
	DEFINE/ANALYZE JOB PERFORMANCE RQTS															
	develop task listing		●			●									●	
	analyze job tasks		●	●										●		
	est. target pop characteristics						●									
DEFINE EDUCATION & TRAINING RQTS	SELECT TASKS REQUIRING TRNG		●			●		●								●
	DETERMINE STUDENT PREREQUISITES						●									
	SELECT APPROPRIATE TRNG SETTING							●							●	
	FORECAST RESOURCE/LOGISTIC RQTS		●		●										●	
DEVELOP OBJECTIVES & TESTS	DEVELOP OBJECTIVES	●	●	●												
	DEVELOP TESTS	●	●			●										●
	DEVELOP JOB PERF TESTING METHODS								●							●

● DENOTES THAT A PROJECT ADDS TO THE TECHNOLOGY OR KNOWLEDGE BASE OF A PROCESS

(Figure 4 continued)

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES	ADV INSTRUCTIONAL DESIGN ADVISOR	ADVANCED OJT-SYSTEM/BTS	BASIC JOB SKILLS	CBT SELECTION ADVISOR	CODAP	FUNDAMENTAL SKILLS TRAINING	JOB-AIDED/TRNG ALLOCATION TECH	JOB PERFORMANCE MEASUREMENT	INSTRUCTIONAL SUPPORT SYSTEM	INTEGRATED MAINT INFO SYSTEM	INTEL COMP-AIDED TRNG TESTBEDS	INTELLIGENT TUTORING SYSTEMS	LOGISTICS COMMAND AND CONTROL	TRNG DECISIONS MODELING TECH	TRAINING EVALUATION
PLAN, DEVELOP & VALIDATE INSTRUCTION	PLAN SEQUENCE OF INSTRUCTION	●														
	SELECT INSTRUCTIONAL METHOD															
	eval alternative instr methods	●			●											●
	select instructional method	●														
	establish detailed course design	●		●												
	SELECT INSTRUCTIONAL MEDIA															
	evaluate candidate media				●											
	select instructional media				●											
	develop system specifications				●											
	DETERMINE RESOURCE AND FUNDING RQTS		●		●										●	
	DEVELOP INSTRUCTIONAL MATERIALS															
	author instructional material	●	●	●						●	●	●				
	produce instructional material	●	●	●						●		●				
	VALIDATE INSTRUCTIONAL MATERIALS															
	review courseware prototype															
	individual & small group tryouts															
	VALIDATE COMPLETE SYSTEM								●							●

● DENOTES THAT A PROJECT ADDS TO THE TECHNOLOGY OR KNOWLEDGE BASE OF PROCESS

(Figure 4 continued)

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES	ADV INSTRUCTIONAL DESIGN ADVISOR	ADVANCED OJT SYSTEM/BTS	BASIC JOB SKILLS	CBT SELECTION ADVISOR	CODAP	FUNDAMENTAL SKILLS TRAINING	JOB-AIDED/TRNG ALLOCATION TECH	JOB PERFORMANCE MEASUREMENT	INSTRUCTIONAL SUPPORT SYSTEM	INTEGRATED MAINT INFO SYSTEM	INTEL COMP-AIDED TRNG TESTBEDS	INTELLIGENT TUTORING SYSTEMS	LOGISTICS COMMAND AND CONTROL	TRNG DECISIONS MODELING TECH	TRAINING EVALUATION
CONDUCT & EVALUATE	DELIVER INSTRUCTION	●	●	●						●		●	●	●		
	SUPPORT INSTRUCTION															
	schedule students		●							●						
	schedule resources		●							●						
	track student progress		●	●						●						
	manage ind training rqts		●													
	maintain & update instr system		●			●					●					
	EVALUATE INSTRUCTION															
	evaluate internal validity		●													●
	evaluate external validity		●						●							
	measure utility & cost-benefit															

● DENOTES THAT A PROJECT ADDS TO THE TECHNOLOGY OR KNOWLEDGE BASE OF A PROCESS

being an integrated management, evaluation, development and delivery system for OJT to a management-oriented system. Nevertheless, the profiles, as presented here, provide a snap-shot of the current direction of AF training technologies.

Training System Problem Profiles

Technology profiles represented one side of the equation in the matching process. On the other side were the profiles for the training system problems. Their purpose was to systematically document those functions of the training system which researchers suspected to be deficient based on their analysis of unit-level training requirements and capabilities (see Table 6 a summary of the training problems). The same ISD analytic framework used by technical directors and project managers to describe their technologies were also used by researchers to translate descriptions of training system problems into sets of specific training system needs. The results of the analyses are shown in Figure 5. Solid circles represent processes where evidence strongly suggests an ISD process is being inadequately performed at the unit level and thus needs improvement. Empty circles represent ISD processes where evidence inconclusively suggests improvements are needed.

Following are the rationale behind construction of each of the problem profiles:

1. **Inappropriate Training Requirements.** This situation strongly indicated a deficiency in the ISD process entitled "select tasks requiring training." Maintainers felt that some of the globally imposed training requirements, such as block training, were entirely inappropriate or overtrained. They also felt that there was an absence or lack of training in others areas, such as CAMS, troubleshooting, basic system knowledge, and Chemical Warfare. Moreover, individuals at the unit-level suffered because managers and supervisors were uncomfortable or unable to make decisions on training content for any individual. This, in turn, negatively impacted the "management of training requirements" at the units. The situation described here strongly suggests that the mechanisms for selecting tasks requiring training, at the unit-level and higher, were either flawed or unavailable.

   This situation may also reflect deficiencies in the processes for "developing task listings" and "analyzing job tasks." For example, an inaccurate job task listing can lead to inappropriate training if it includes irrelevant tasks or to a lack of training if it excludes relevant tasks. Moreover, if tasks were not properly analyzed, they could lead to over- or under-training. Given the level of data and primitive state of the framework, however, these conclusions are speculative at best.

Figure 5. ISD Processes Indicated As Deficient By Training System Problems

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES	INAPPROPRIATE TRAINING REQUIREMENTS	LACK OF QUALIFIED INSTRUCTORS/TRAINERS	MANPOWER AND PERSONNEL POLICIES	NEED FOR ENHANCED HANDS-ON TRAINING/OJT	LACK OF TRAINING OPPORTUNITIES	LIMITED TRAINING TIME	LACK OF ENROUTE TRAINING	INADEQUATE FEEDBACK MECHANISMS	INADEQUATE JPM PROCEDURES	LACK OF TDY FUNDING	IMPLEMENTATION PROBS W/ TRNG MEDIA	SUMMARY OF TRAINING SYSTEM NEEDS
ANALYZE SYSTEM REQUIREMENTS	TRNG NEEDS ASSESSMENT												
	analyze situation												
	identify parameters												
	DEFINE/ANALYZE JOB PERFORMANCE RQTS												
	develop task listing	○											○
	analyze job tasks	○											○
	est. target pop characteristics												
DEFINE EDUCATION & TRAINING RQTS	SELECT TASKS REQUIRING TRNG	●	●			●							●
	DETERMINE STUDENT PREREQUISITES												
	SELECT APPROPRIATE TRNG SETTING		●								○		●
	FORECAST RESOURCE/LOGISTIC RQTS		●								○		●
DEVELOP OBJECTIVES & TESTS	DEVELOP OBJECTIVES												
	DEVELOP TESTS												
	DEVELOP JOB PERF TESTING METHODS									●			●

● EVIDENCE STRONGLY SUPPORTS THE EXISTENCE OF A DEFICIENCY IN PROCESS

○ EVIDENCE PROVIDES SOME SUPPORT FOR DEFICIENCY IN PROCESS (INCONCLUSIVE)

(Figure 5 continued)

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES	INAPPROPRIATE TRAINING REQUIREMENTS	LACK OF QUALIFIED INSTRUCTORS/TRAINERS	MANPOWER AND PERSONNEL POLICIES	NEED FOR ENHANCED HANDS-ON TRAINING/O	LACK OF TRAINING OPPORTUNITIES	LIMITED TRAINING TIME	LACK OF ENROUTE TRAINING	INADEQUATE FEEDBACK MECHANISMS	INADEQUATE JPM PROCEDURES	LACK OF TDY FUNDING	IMPLEMENTATION PROBS W/ TRNG MEDIA	SUMMARY OF TRAINING SYSTEM NEED
PLAN, DEVELOP & VALIDATE INSTRUCTION	PLAN SEQUENCE OF INSTRUCTION												
	SELECT INSTRUCTIONAL METHOD				●		●						●
	eval alternative instr methods												
	select instructional method												
	establish detailed course design												
	SELECT INSTRUCTIONAL MEDIA				●	●	●					●	●
	evaluate candidate media												
	select instructional media												
	develop system specifications												
	DETERMINE RESOURCE AND FUNDING RQTS											●	●
	DEVELOP INSTRUCTIONAL MATERIALS												
	author instructional material												
	produce instructional material												
	VALIDATE INSTRUCTIONAL MATERIALS												
	review courseware prototype												
	individual & small group tryouts												
	VALIDATE COMPLETE SYSTEM												

● EVIDENCE STRONGLY SUPPORTS THE EXISTENCE OF A DEFICIENCY IN PROCESS

○ EVIDENCE PROVIDES SOME SUPPORT FOR A DEFICIENCY IN PROCESS (INCONCLUSIVE)

(Figure 5 continued)

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES	INAPPROPRIATE TRAINING REQUIREMENTS	LACK OF QUALIFIED INSTRUCTORS/TRAINERS	MANPOWER AND PERSONNEL POLICIES	NEED FOR ENHANCED HANDS-ON TRAINING/OJT	LACK OF TRAINING OPPORTUNITIES	LIMITED TRAINING TIME	LACK OF ENROUTE TRAINING	INADEQUATE FEEDBACK MECHANISMS	INADEQUATE JPM PROCEDURES	LACK OF TDY FUNDING	IMPLEMENTATION PROBS W/ TRNG MEDIA	SUMMARY OF TRAINING SYSTEM NEEDS
CONDUCT & EVALUATE	DELIVER INSTRUCTION				●		●						●
	SUPPORT INSTRUCTION												
	schedule students							●					●
	schedule resources		●										●
	track student progress												
	manage ind training rqts	●											●
	maintain & update instr system								●				●
	EVALUATE INSTRUCTION												
	evaluate internal validity												
	evaluate external validity								●				●
	measure utility & cost-benefit												

● EVIDENCE STRONGLY SUPPORTS EXISTENCE OF A DEFICIENCY IN PROCESS

○ EVIDENCE PROVIDES SOME SUPPORT FOR A DEFICIENCY IN PROCESS (INCONCLUSIVE)

2. **Lack of Qualified Instructors and OJT Trainers.** This situation was largely a resource problem, in terms of both quantity and quality. The lack of available instructors (i.e., the quantity problem) indicated deficiencies in the ability to "select appropriate training settings" and "forecast resource/logistic requirements." On the one hand, there was a failure to adequately forecast and assign the necessary number of instructors to FTDs, MATs, and units (although this may have been a function of external constraints such as manpower shortages). On the other hand, this situation indicates that training was inappropriately allocated to training settings with insufficient resources. This situation may also indicate an inability at the unit level to properly "schedule resources" for training. When instructors were available, many of them appeared to lack technical competency and/or teaching abilities. The latter situation strongly indicates that a problem existed in the "selection training requirements" for instructors. This conclusion is further supported by the apparent lack of available courses on the subject of teaching. However, the evidence surrounding the former problem, i.e., lack of technical competency, is for the most part unclear as to its implications. It may indicate potential deficiencies in a number of training processes, but further investigation would be required to determine which ones resulted in the lack of technical competence amongst some instructors.

3. **Manpower and Personnel Policies.** This situation does not implicate any specific training process. It is, in fact, an external factor (situational constraint) which adversely affects the training system by increasing training requirements.

4. **Enhanced Hands-On Training/OJT.** This situation is quite broad in its implications, suggesting improvement to all aspects of OJT including planning, management, evaluation, development and delivery. The emphasis, however, is on "delivery" and the need for "instructional methods" and "instructional media" which accentuate hands-on skill training. It is unclear from the data which, if not all, of the subprocesses in the selection of instructional methods and media are implicated by this problem.

5. **Lack of Training Opportunities Due To Improved Weapon System Technology.** This situation clearly indicates the need for instructional developers to "select instructional media" which will enable maintainers to train on tasks which infrequently occur because of extremely high weapon system reliability rates. This also indicates a need for an improved "training requirements selection" process so that

infrequently performed task are identified for recurring training.

6. **Limited Training Time Due To Operational Commitments.** This situation is quite complex and indicates areas needing improvement within training and external to it. External factors which limit time include mission requirements and limited manpower. The implication for training is to increase the efficiency and availability of training through enhanced "selection of instructional methods" and "media" and to make "delivery" of training more accessible/convenient.

7. **Lack of Enroute Training.** The circumstances surrounding this situation point to problems in the assignment process and deficiencies in the "scheduling of students." According to interviewees, the procedures for scheduling students for enroute training were slow and unreliable.

8. **Inadequate Feedback Mechanisms For Evaluating Training Courses.** This situation indicates a need for enhanced feedback mechanisms to support the "maintenance and update of the instructional system" and the "evaluation of the external validity of the instructional product." Maintainers had mixed impressions about whether or not their inputs regarding the content of training courses were being received and, when received, used by course developers to evaluate and update their courses.

9. **Inadequate Job Performance Measurement Procedures.** This situation points to deficiencies in the "development of job performance testing procedures". Maintainers claimed that QA evaluations were unstandardized and inconsistent across evaluators. Moreover, many of the maintainers and some QA personnel felt that the evaluations were not a good measure of a unit's capabilities since the same set of personnel seemed to be evaluated every time QA visited a unit. For example, personnel on swing shifts rarely were evaluated. QA evaluators were also criticized for not being proficient in the tasks they evaluated. This problem, however, seemed to be a temporary one brought about by Rivet Workforce training requirements and should dissipate once QA personnel become more familiar with the rivetized tasks. (QA personnel also performed evaluations of student performance in conjunction with AMQP. However, it is unclear from the data whether or not these training evaluations suffered from the same lack of standardization as did the job performance evaluations.)

10. **Lack of TDY Funding.** This situation is predominantly a reflection of recent budget cutbacks. It is likely,

however, that training managers were unable to forecast the resource, cost, and performance impacts of their decisions and, therefore, provided relied on OJT rather than sending someone TDY to school. This, in turn, indicates training settings were inappropriately selected (i.e., selection by default). For example, training someone on a certain task or set of tasks in OJT may be more costly in terms of labor hours and resources than sending that person TDY.

11. **Implementation Problems with New Training Media.** This situation pertains to IVD technology, in particular, and indicates that resources were not properly identified and provided to support IVD use and implementation at the unit-level. Moreover, training personnel did not know when, where, or how to use that particular media.

The interview data and findings from the content analysis strongly support the existence of deficiencies in a large number of training processes. These deficiencies represent deficiencies with the unit-level training system as a whole and are not necessarily confined to the units themselves. For example, many of the processes at the front-end of the framework (i.e., "Analyze System Requirements"; "Define Education and Training Requirements"; "Develop Tests and Objectives"; "Plan, Develop and Validate Instruction") are often accomplished by organizations outside the unit-level. The results of these activities, however, are nonetheless intimately linked to the unit-level training system. It is important to understand unit-level training as a system and not as an isolated activity.

Table 7 contains a summary of the specific ISD processes implicated by the problems described in previous chapters. Only those processes which are strongly supported by the data are listed here. The degree to which each of the processes is deficient is unclear since no metric existed for determining the severity of each problem. Based on the number of problem descriptions (Table 6) which implicated a particular process, it would appear that "Selection of Tasks Requiring Training", "Selection of Instructional Media", "Selection of Instructional Methods", and "Delivery of Training" are the processes with more pronounced deficiencies. However, such a finding would be extremely tentative.

The results of this analysis should be interpreted cautiously for several reasons. First, it is likely that other researchers would have differing interpretations of the problems described in this paper, and therefore, differing profiles and conclusions. Second, since instructional development is an integrated process, it becomes difficult to implicate any single process as being deficient. Problems may result from weaknesses in several processes, or the deficiencies in one process may overshadow or mask deficiencies in others. Finally, the results are limited by the specificity and scope of the Phase I SLT data. Researchers developed the analytic framework used in this analysis after data collection had already been completed. Consequently, this framework did not guide the data collection effort. Data collection was instead guided by a similar, yet much broader,

Table 7

Summary of Training Processes Implicated by SLT Phase I Findings

1) Selection of Tasks Requiring Training;
2) Selection of Appropriate Training Settings;
3) Forecast of Resource/Logistics Requirements;
4) Development of Job Performance Testing Standards;
5) Selection of Instructional Methods;
6) Selection of Instructional Media;
7) Delivery of Instruction;
8) Scheduling of Students;
9) Scheduling of Resources;
10) Management of Individual Training Requirements;
11) Maintenance and Update of Instructional Systems; and,
12) Evaluation of External Validity of Instructional Product.

framework than the ISD model provided. This limited the ability of researchers to identify accurately the specific training system needs implied by the data. They were, for example, unable to identify the specific ISD processes within media and method selection implicated by the problem descriptions. This inability was largely due to the lack of specificity in the data collected. Such a situation could have been avoided if data collection had been focused along the lines of the ISD-based analytic framework.

Training Needs-Technology Match

The final step in the matching process involved a comparison of the technology and training system deficit profiles. The purpose of such a comparison is to reveal where training system needs are being addressed by AF training research and where they are not. The results of the matching process can be seen in Figure 6. The shaded areas represent processes which were implicated as being deficient from earlier analyses. An overlap (or "hit") exists when solid circle appears in the shaded area. This indicates that the deficient ISD process is addressed by a training technology. The mere fact that an overlap exists, however, is not confirmation in and of itself that a system need is being addressed. Since the analytic framework used in this matching process is very basic and only considers function, researchers have to consider other issues such as the context surrounding a training need (domain) and the degree to which a technology addressed this context in addition to the basic overlap.

Figure 6. Training Technology and Training System Needs Match Indicating Areas For Potential Application

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES	ADV INSTRUCTIONAL DESIGN ADVISOR	ADVANCED OJT SYSTEM/BTS	BASIC JOB SKILLS	CBT SELECTION ADVISOR	CODAP	FUNDAMENTAL SKILLS TRAINING	JOB-AIDED/TRNG ALLOCATION TECH	JOB PERFORMANCE MEASUREMENT	INSTRUCTIONAL SUPPORT SYSTEM	INTEGRATED MAINT INFO SYSTEM	INTEL COMP-AIDED TRNG TESTBEDS	INTELLIGENT TUTORING SYSTEMS	LOGISTICS COMMAND AND CONTROL	TRNG DECISIONS MODELING TECH	TRAINING EVALUATION
ANALYZE SYSTEM REQUIREMENTS	TRNG NEEDS ASSESSMENT															
	analyze situation						●	●								
	identify parameters				●			●						●		
	DEFINE/ANALYZE JOB PERFORMANCE RQTS															
	develop task listing		●			●									●	
	analyze job tasks		●	●										●		
	est. target pop characteristics						●									
DEFINE EDUCATION & TRAINING RQTS	SELECT TASKS REQUIRING TRNG		●			●		●								●
	DETERMINE STUDENT PREREQUISITES						●									
	SELECT APPROPRIATE TRNG SETTING							●							●	
	FORECAST RESOURCE/LOGISTIC RQTS		●		●										●	
DEVELOP OBJECTIVES & TESTS	DEVELOP OBJECTIVES	●	●	●												
	DEVELOP TESTS	●	●			●										●
	DEVELOP JOB PERF TESTING METHODS								●							●

● DENOTES THAT A PROJECT ADDS TO THE TECHNOLOGY OR KNOWLEDGE BASE OF A PROCESS

(Figure 6 continued)

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES	ADV INSTRUCTIONAL DESIGN ADVISOR	ADVANCED OJT SYSTEM/BTS	BASIC JOB SKILLS	CBT SELECTION ADVISOR	CODAP	FUNDAMENTAL SKILLS TRAINING	JOB-AIDED/TRNG ALLOCATION TECH	JOB PERFORMANCE MEASUREMENT	INSTRUCTIONAL SUPPORT SYSTEM	INTEGRATED MAINT INFO SYSTEM	INTEL COMP-AIDED TRNG TESTBEDS	INTELLIGENT TUTORING SYSTEMS	LOGISTICS COMMAND AND CONTROL	TRNG DECISIONS MODELING TECH	TRAINING EVALUATION
PLAN, DEVELOP & VALIDATE INSTRUCTION	PLAN SEQUENCE OF INSTRUCTION	●														
	SELECT INSTRUCTIONAL METHOD															
	eval alternative instr methods	●			●											●
	select instructional method	●														
	establish detailed course design	●		●												
	SELECT INSTRUCTIONAL MEDIA															
	evaluate candidate media				●											
	select instructional media				●											
	develop system specifications				●											
	DETERMINE RESOURCE AND FUNDING RQTS		●		●										●	
	DEVELOP INSTRUCTIONAL MATERIALS															
	author instructional material	●	●	●						●	●	●				
	produce instructional material	●	●	●						●		●				
	VALIDATE INSTRUCTIONAL MATERIALS															
	review courseware prototype															
	individual & small group tryouts															
	VALIDATE COMPLETE SYSTEM								●							●

● DENOTES THAT A PROJECT ADDS TO THE TECHNOLOGY OR KNOWLEDGE BASE OF PROCESS

(Figure 6 continued)

INSTRUCTIONAL SYSTEM DEVELOPMENT	PROCESSES	ADV INSTRUCTIONAL DESIGN ADVISOR	ADVANCED OJT SYSTEM/BTS	BASIC JOB SKILLS	CBT SELECTION ADVISOR	CODAP	FUNDAMENTAL SKILLS TRAINING	JOB-AIDED/TRNG ALLOCATION TECH	JOB PERFORMANCE MEASUREMENT	INSTRUCTIONAL SUPPORT SYSTEM	INTEGRATED MAINT INFO SYSTEM	INTEL COMP-AIDED TRNG TESTBEDS	INTELLIGENT TUTORING SYSTEMS	LOGISTICS COMMAND AND CONTROL	TRNG DECISIONS MODELING TECH	TRAINING EVALUATION
CONDUCT & EVALUATE	DELIVER INSTRUCTION	●	●	●						●		●	●	●		
	SUPPORT INSTRUCTION															
	schedule students		●							●						
	schedule resources		●							●						
	track student progress		●	●						●						
	manage ind training rqts		●													
	maintain & update instr system		●			●					●					
	EVALUATE INSTRUCTION															
	evaluate internal validity		●													●
	evaluate external validity		●						●							
	measure utility & cost-benefit															

● DENOTES THAT A PROJECT ADDS TO THE TECHNOLOGY OR KNOWLEDGE BASE OF A PROCESS

The results of this matching process are discussed in the remainder of this section, focusing on each of the processes listed as deficient in Table 7 and their relationship to AF training technology research.

The ISD process entitled "select tasks requiring training" was implicated as being deficient several times in the analysis of training system problems. Figure 6 indicates that four technologies (i.e., projects) enhance the knowledge or technology base for the selection of training requirements, including the Advanced OJT System (AOTS)/BTS, the Comprehensive Occupational Data Analysis Package (CODAP), Job-Aiding/Training Allocation Technologies (JATAT), and Training Evaluation. Each of these technologies is intended to enhance the training requirements selection process in a slightly different manner. Unfortunately, the analytic framework, as it is currently defined, does not distinguish between these subtle differences. Even if it could, the level of specificity of the data would preclude a more in depth comparison of needs and technologies. Suffice it to say that, based on the interview data, resources for accurately selecting training tasks need to exist at all levels of the training system. This will enable training managers to tailor training requirements to their particular situations.

Deficiencies in the processes for "selecting appropriate training settings" and "forecasting resource logistic requirements" appear to be closely related. The reason being that forecasting resource and logistic requirements was an important step in determining appropriate training settings. In other words, the appropriateness of a training setting was largely dependent upon the adequacy of its resources. Three of the training technologies, the AOTS, CBT Selection Advisor, and the Training Decisions Modeling Technologies (TMDT), provide a capability for forecasting resource and logistic requirements. However, only one of these technologies, the TDMT, goes the additional step and enhances the process for selecting appropriate training settings based on the forecasted resource and logistic requirements.

At a very broad level, the process for "selecting instructional methods" was implicated by two of the apparent training system problems. Several technologies, including the Advanced Instructional Design Advisor (AIDA), Basic Job Skills (BJS), CBT Selection Advisor, and Training Evaluation, address some, if not all, aspects of this deficiency. Unfortunately, as previously stated, researchers could not discern from the data which of the subprocesses needed improvement, and therefore, it is unclear which technologies truly address the deficiency. The only exception to this would be AIDA which addresses each aspect of method selection.

The CBT Selection Advisor is the only technology which addresses the deficiencies in "selecting instructional media". It would appear that this technology fully addresses the deficiencies in media selection, but appearances can be deceiving. The overlaps shown in Figure 6 simply indicate that a technology enhances the same type of functions which have been identified as deficient. A closer examination of the situation reveals that the technology in question is intended to enhance media selection and use within one specific context -- computer-based training. The deficiencies indicated by the Phase I research appear to encompass media selection at a more general level; that is, it is not content specific. Training developers and manager need help identifying training media, CBT or other, suitable to the unit-level environment. Whether or not the CBT Selection Advisor can be adapted for media selection in general is unknown.

Deficiencies in the "determination of resource and funding requirements" for IVD instruction contributed to the poor implementation of this category of instruction at units. The AOTS, CBT Selection Advisor, and TDMT are possible solutions to this deficiency, however. These technologies would enable training developers to determine the exact resource and funding requirements necessary to support their instruction prior to actually implementing it.

Training delivery is the most salient process in the instructional system and is the culmination of all the other processes. It is, if you will, "where the rubber meets the road." Of the fifteen training technologies of concern in this study, almost half (i.e., seven) of them are intended to enhance the delivery of instruction. They do so through a variety of computer-based and intelligent tutoring systems. However, deficiencies which appear in the delivery process are often the result of deficiencies in other processes. While the interview data suggests that the delivery of instruction needs improvement to overcome problems in the unit-level environment such as limited training time, it is likely that the delivery problem would be solved if other processes (e.g., selection of instructional media) were improved.

All but one of the processes within the instructional support area were identified as deficient. These processes, along with instructional delivery and evaluation, are perhaps the most germane to operational units (as opposed to the training planning, programming and development functions which typically occur outside the units themselves). According to the data collected at PACAF F-16 maintenance units, the scheduling of both resources (i.e., instructors) and students (i.e., for enroute training) was deficient. The AOTS/BTS and Instructional Support System (ISS) are intended to address this type of deficiency. In fact, the AOTS/BTS incorporates ISS technology into itself.

Deficiencies in the "management of individual training requirements" also degraded the instructional support capabilities of unit-level training. This situation is very much related to the problem surrounding "selection of tasks requiring training" and may, in fact, only be a consequence of this deficiency. In this case, however, training managers were unable or unwilling to tailor training requirements to the needs of individuals at a job-site as opposed to the needs of an AF specialty or one of its shreds. The AOTS, once again purports to enhance the process for managing individual training requirements. It is also likely that the capabilities found in CODAP, JATAT, and Training Evaluation are applicable to this process (just as they are to "selection of tasks requiring training").

Instructional support also suffered from deficiencies in the "maintenance and update of the instructional system." More specifically, interviewees felt that training courses were not being updated or modified based on feedback from the field (via follow-up surveys, course critiques, and informal communications). Several technologies offer potential solutions to this problem by strengthening the feedback loop between the field and the course developers, instructors and administrators. These technologies include AOTS, CODAP, and the Integrated Maintenance Information System (IMIS). Whether or not the information provided by these technologies is actually used to update courses is a separate question beyond the scope of this research.

Finally, the deficiencies in the feedback mechanisms just described also indicate deficiencies in the process for "evaluating the external validity of instruction." The fact that some interviewees felt courses were not being updated to reflect the realities of the operational environment also indicates that the external validity of some courses is questionable (at least in terms of their face validity). The AOTS and JPM technologies are intended to improve this process in the training system. The information generated by these technologies should allow course developers to evaluate the degree to which their courses teach the skills and knowledges relevant to the work environment including appropriateness of course content and transfer of training.

D. Discussion of Matching Process

At first glance, there would appear to be no apparent gaps in the AF training technology research. Each of the ISD processes that researchers found to be deficient in the unit-level training system for PACAF F-16 maintenance units are in some way addressed by a training technology. The only area which may be overlooked is that of training media selection. Currently, only one technology, the CBT Selection Advisor, addresses this problem, but it does so from a CBT perspective only.

The training system needs and technology match also reveals areas where technologies are focused but which were not implicated by the data as being deficient. However, this does not mean that the technologies are "misguided." First of all, this study was limited to PACAF F-16 maintenance units. The training technologies, on the other hand, are being developed for a broader AF application. Second, while only certain processes were implicated as deficient at the unit level, improvements made to any of the processes are potentially beneficial to unit-level training.

Finally, the data collection instruments used in this study were not based on the analytic framework as seen in figures 4, 5, and 6. Consequently, there is some degree of error in the results presented here.

Moreover, the framework presented in this report has a number of limitations which should also be acknowledged. It was developed specifically for describing and relating training technologies to training system needs at a very basic level; that is, it merely shows where the functions of training technologies match deficiencies in the training system. The framework does not, for instance, specify the theoretical principles, procedures, and rules for developing and operationalizing constructs, and for analyzing and interpreting data (see Ostroff & Ford, 1989). Nor does the framework explicitly address the issue of training domains; i.e., the specific contextual areas with which training technologies or deficits are associated, such as aircrew, maintenance, and the like.

Nevertheless, the analytic framework represents an important, although preliminary step toward development of a systematic process for identifying and describing training system needs, cataloguing training technology functions, and relating the two. Future work in this area would greatly benefit from the theoretical developments found in training needs assessment research. Ostroff and Ford (1989), for example, presented a model of needs assessment based on a levels perspective. According to this model, training needs occur at three levels: organizational, subunit, and individual. Each of these levels of analysis has implications for construct development, operationalization, and interpretation. It is likely that these concepts would also be applicable to training systems needs assessment should research continue in this area.

In summary, the data indicates that training system needs are being addressed by training technologies. These relationships, however, deserve a more in depth examination. Researchers must go beyond the question of whether or not technologies are functionally matched to deficiencies. They must examine issues such as the degree to which a technology meets a need, the seriousness of a training system need, and the context surrounding the deficiencies. Such an examination would reveal specific areas where training technologies could be focused in order to increase their applicability to unit-level training. Before this can take place, researchers must first advance the framework which has guided the analysis described in this chapter.

VI. CONCLUSIONS

Phase I of the Squadron Level Training research effort provided researchers with a greater understanding of the unit-level training environment and the potential for training technology applications within PACAF F-16 maintenance units. It identified trends in current training requirements, evaluated the training capabilities at the unit-level, identified factors facilitating or inhibiting training, and provided a preliminary match between technologies and problem areas within the overall unit-level training system. However, the primary benefits derived from this initial phase of research were the methodologies and future directions suggested by it. This information should form the basis for a more comprehensive follow-on study.

Findings from Phase I suggest that units, at least PACAF F-16 maintenance units, are facing a complex training environment. Fluctuations in experience levels amongst maintenance personnel, advances in weapon system technology, and policies such as Rivet Workforce have increased training requirements for maintenance units. At the same time, the data suggests that the unit-level training system has numerous deficiencies. These deficiencies exist at all levels within the training system, from the selection of tasks requiring training to the selection of instructional media to the evaluation of instructional products. Fortunately, it appears as though AF training technologies address, to a greater or lesser extent, each the deficiencies identified in this research.

While this research provides some insight into unit-level training, findings from this research are restricted to a small segment of the AF; namely, PACAF F-16 maintenance units. As such, these findings have limited generalizability. The strength of the Phase I research, however, is not limited to its analysis of F-16 maintenance units, per se. Instead, this research provides the AF with suggestions for the continued study of unit-level training.

Interviews with trainees, trainers, and training managers and the associated content analyses resulted in a number of valuable lessons for researchers. First, it reinforced the fact that training exists as a system. At the unit level, personnel engage in a variety of training activities including the day-to-day management of training, training delivery, and training evaluation. Other activities such as training planning and development, while typically occurring outside the unit, significantly impact unit-level training nonetheless. Consequently, future research should continue to examine each aspect of the training system as it relates to unit-level training.

Second, the information gathered during data collection in this phase will help guide the development of surveys in the next effort. This information has provided researchers with insight into the types of data available at the unit level and the types of information unit personnel are capable of providing or understanding. For example, researchers found that very few maintenance personnel knew what an IVD system was.

Finally, Phase I resulted in the development of an ISD-based framework for analyzing training technologies and training system needs, and then relating the two. This framework, although only preliminary, provides an excellent structure for guiding and focusing future data collection and analysis. Moreover, it lays the foundation for development of a more versatile tool which can be used to evaluate the application of training technologies to the unit-level training system in terms of its appropriateness, cost/benefits, feasibility, and other criteria (see Appendix G for a list of potential evaluative criteria). The outcome from such an analysis will be a Science & Technology Plan for guiding the development and implementation of HSD training technologies.

In an environment of increasing training requirements and decreasing dollars, training research must take the most prudent and expedient route. The research described in this paper represents an initial step toward understanding and evaluating the application of training technologies. However, this research must be refined and extended to enlisted personnel in all AF support units in order to provide AF training technology researchers with information about the most promising opportunities for the application of training technologies.

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APPENDIX A: GLOSSARY

LIST OF ACRONYMS

ABDR	Aircraft Battle Damage Repair
AFETS	Air Force Engineering and Technical Services
AFHRL	Air Force Human Resources Laboratory
AFJQS	Air Force Job Qualification Standard
AFMPC	Air Force Military Personnel Center
AFS	Air Force Specialty
AFSC	Air Force Specialty Code
AGS	Aircraft Generation Squadron
AIDA	Advanced Instruction Design Advisor
AL/HR	Human Resources Directorate of the Armstrong Laboratory (formerly the Air Force Human Resources Laboratory)
AMQP	Aircraft Maintenance Qualification Program
AMU	Aircraft Maintenance Unit
AOTS	Advanced On-the-Job Training System (now called Base Training System)
ATC	Air Training Command
ATS	Advanced Training System
BJS	Basic Job Skills
CAMS	Core Automated Maintenance System
CASB	Combat Ammunition System Base
CBI	Computer Based Instruction
CBT	Computer Based Training
CDC	Career Development Course
CJQS	Command Job Qualification Standard

COMO	Combat Oriented Maintenance Organization
CRS	Component Repair Squadron
CUT	Cross-Utilization Training
DCM	Deputy Commander for Maintenance
EMS	Equipment Maintenance Squadron
EST	Enlisted Specialty Training
FTD	Field Training Detachment
HQUSAF	Headquarters United States Air Force
HSD	Human Systems Division
ICATT	Intelligent Computer-Aided Training Testbeds
IMIS	Integrated Maintenance Information System
ISD	Instructional System Development
ISS	Instruction Support System
ITT	Intelligent Training Technologies
IVD	Interactive Videodisc
JATAT	Job-Aiding/Training Allocation Technologies
JQS	Job Qualification Standard
MAJCOM	Major Command
MAT	Office symbol for branch of TMD (formerly Maintenance Training [Division])
MI	Maintenance Instructor
MTBF	Mean Time Between Failure
MTL	Master Task List
MTT	Mobile Training Team
MTTR	Mean Time to Repair
NAF	Numbered Air Force
NCO	Noncommissioned Officer

OJT	On-the-Job Training
OMC	Occupational Measurement Center
OSR	Occupational Survey Report
PACAF	Pacific Air Forces
PCS	Permanent Change of Station
PME	Professional Military Education
QA	Quality Assurance
RWF	Rivet Workforce
SEI	Special Experience Identifier
SLT	Squadron Level Training
SME	Subject Matter Expert
SOW	Statement of Work
STS	Specialty Training Standard
TAC	Tactical Air Command
TDMT	Training Decisions Modeling Technologies (TDS forms the baseline technology)
TDY	Temporary Duty
TMD	Training Management Division
TO	Technical Order
TOT	Task Oriented Training
UES	UES, Inc. (formerly Universal Energy Systems, Inc.)

LIST OF TERMS

Ancillary training Training for functional or additional duty tasks done outside the scope of the primary job (e.g., CPR, Code of Conduct).

Archival data Existing records and information which may be accessed to provide details of on-going operations or historical occurrences.

Attribute A distinguishing feature or component of a training technology.

Block training The consolidation of training requirements into a block of instruction to be presented in a single training session.

Cross Utilization Training Tasks outside the normal duty of an AFSC that are included in the STS to provide flexibility under austere conditions.

Development and Delivery All activities concerned with authoring and delivering instruction such as test development, curriculum development, identification of delivery methods, and delivering instruction.

Enroute training Training received attendant to a permanent change of station at a location other than the permanent duty station, usually at an FTD.

Homogeneity analysis The degree to which the units surveyed show commonality among responses to the interview questions regarding training needs, capabilities, and so on.

Job-related training Task-specific and technical training; includes initial/qualification, continuation, upgrade, requalification, conversion, and other (e.g., FTD)

Management and Evaluation The day-to-day operation of training including scheduling students, courses, and classes; keeping of individual, course, and class records; resource management; and evaluating students, courses, and training systems.

Operational level The lowest level of the organization at which the actual day-to-day production, maintenance, and so on gets accomplished.

Planning and Programming All activities undertaken to plan or program training for Air Force personnel. This includes all aspects of establishing instruction such as identifying the who, what, when, and where of training; budgeting and resource actions; and acquisition of training.

Reliability The dependability of a training device or method during use. This can also be thought of as "does the equipment usually work or not?"

Shredout An alphabetical suffix attached to an AFSC to identify specific equipment, functions, or positions within a specialty.

Training capabilities The unit-level resources available for training (e.g., time away from primary duties, materials, equipment, experienced personnel to serve as instructors, budget for supplies and TDY funding).

Training environment Description of the factors which influence the provision of unit level training, such as organizational mission, manning issues, training requirements, and training capabilities.

Training function Reflects three levels of involvement in the training system: Planning and Programming, Management and Evaluation, and Development and Delivery.

Training needs Specific processes within the training system which need improvement; these deficiencies contribute to the manifestation of observable training problems

Training problems General situations which degrade training; they are manifestations of underlying deficiencies in the training system and its environment

Training requirements Current and future training as specified by AF, MAJCOM, and unit-level doctrine; specifications to include types of training, training content, and amounts of training to be conducted (e.g., number of trainees, length of training, frequency of training).

Training system The ordered arrangement of processes for planning, programming, managing, evaluating, developing and delivering training within a given environment.

Training technologies Any process for transforming physical and informational inputs into training outputs; may be either currently existing or in the development process.

Transfer opportunities. The feasibility of relocating training performed at central location to the unit level, and vice versa.

APPENDIX B:

LIST OF INFORMATIONAL INTERVIEWS BY OFFICE SYMBOL

Headquarters USAF, Washington DC

LEXY
LEYM
LEYW
LEYX
DPPT

Headquarters Tactical Air Command, Langley AFB, VA

LGM
LGMF-16
LGQ
LGQT
LGQP

Headquarters Pacific Air Forces, Hickam AFB, HI

DPAT
LGMS
LGMM
LGMMR
LGMFB
LGWS
TTA

Headquarters Air Training Command, Randolph AFB, TX

TTO
ACC

Headquarters AF Military Personnel Center, Randolph AFB, TX

DPMRPQ

APPENDIX C: DATA COLLECTION INTERVIEW PROTOCOL

SQUADRON LEVEL TRAINING RESEARCH INITIATIVE

STRUCTURED INTERVIEW

(MAINTENANCE)

Good morning/afternoon/evening. I'm . . . . . from the Air Force Human Resources Laboratory, Air Force Systems Command. I'm part of a team here to study research issues in unit level training specifically dealing with F-16 maintenance units. We would like to emphasize that your personal comments will remain strictly confidential and your answers will be combined with other maintenance responses in a group summary. All of the information will be used by AFHRL and the Human Systems Division of AFSC to help guide research in unit level training over the next six to twelve years.

We are going to first ask you some questions about yourself then follow with some questions concerning training at the operational unit.

Do you have any questions? . . . . Ok fine, then let's get started.

DEMOGRAPHICS

GRADE (circle one):

2Lt 1Lt Capt Major Lt Col Col

Amn A1C SRA Sgt SSgt TSgt MSgt SMsgt CMSgt

MAJCOM (circle one):

PACAF TAC HQ PACAF HQ TAC Air Staff

BASE: __________

UNIT: __________

TIME IN UNIT: __________

JOB TITLE: ________________

DAFSC: __________

Previous Maintenance AFSC(s): _________

TIME POSITION: ___________

TOTAL MAINTENANCE TIME: ___________

TOTAL F-16 MAINTENANCE TIME: ___________

UNIT MISSION:

CURRENT ROLE IN UNIT TRAINING PROCESS:

OPERATIONAL PERSPECTIVE

"I want to ask you some questions about your perceptions and experiences with training in your unit. The first set of questions will focus on training requirements."

A. Training

1. What types of job and ancillary training are currently conducted:

    a. at the unit itself?
    b. at FTDs?
    c. at MATs?
    d. at other locations?

2. Is there any job or ancillary training currently being conducted which is not needed?

3. Are there any topics or tasks which are overtrained?

4. Is there any job or ancillary training currently not being conducted which should be trained?

5. Are there any topics or tasks which are undertrained?

6. Is there any training that is currently conducted at the unit level which you feel should be conducted elsewhere (i.e., at FTDs, MATs, tech school)?

    Yes:

    a. Which training?
    b. Where should it be conducted?
    c. Why?

7. Is there any training that is currently conducted away from the squadron which you think should be conducted at the squadron?

    Yes:

    a. Which training?
    b. Why?

8. Will training needs be different in the future?

Yes

a. What will change?
b. What effect will this have on unit training?
c. How will this affect mission readiness?

B. Planning/Programming

"This next set of questions focuses on the Planning and Programming of training. Planning and Programming includes such activities as identifying the who, what, when, and where of training; budgeting and resource actions; and acquisition of training."

1. Are you involved in planning and programming training?

Yes

a. Function?

___ planning/programming
___ training content
___ training content allocation
___ training time allocation
___ budgeting
___ resource planning

b. What specific products or services do you provide with regard to your planning/programming function?

EX: OPR for regulations
news letters
reports

c. Do you interact with any other organizations or individuals when performing your planning/programming function?

d. What information do you use in your planning/programming function?

e. What information would you like to have for your planning/programming function?

f. Do you have any structured procedures for your planning/programming function?

EX: regulations
locally prescribed

procedures

g. What tools or methods do you currently use to accomplish your planning/programming function?

develop
evaluate
update

h. Do you have access to any tools or methods which are intended to help you in your planning/programming function but which you don't use?

i. What tools or methods would you like to have to do your planning/programming function?

develop
evaluate
update

j. Do you foresee any future occurrences or events which will impact training planning and programming?

k. Are there any other problems in planning and programming we have not already discussed?

l. Where do you see the highest payoff with regard to the use of tools/methods in planning and programming?

m. Other persons who we should talk to?

2. Is your unit given sufficient voice in tailoring training (the what, when, and where) to unit specific missions?

3. Are there any feedback mechanisms in place which allow you or your unit to influence training?

Yes:

a. What are they?
b. Are they effective?

4. Are there any feedback mechanisms you would like to see implemented?

5. Are you generally satisfied with the planning and programming of training?

C. Management

"These next questions will focus on training management. These activities include the day to day operations of training such as planning individual training; resource management; scheduling students, courses, and classes; and, keeping individual, course, and class records."

1. Are you involved in the day-to-day management of training?

Yes

a. Function?

___ individual training planning
___ scheduling students/courses
___ resource management
___ recordkeeping, students/courses

b. What specific products or services do you provide with regard to your management function?

EX: OPR for regulations
news letters
reports

c. Do you interact with any other organizations or individuals when performing your management function?

d. What information do you use in your management function?

e. What information would you like to have for your management function?

f. Do you have any structured procedures for your management function?

EX: regulations
local procedures

g. What tools or methods do you currently use to accomplish your management function?

develop
evaluate
update

--to determine individual training requirements

--to track training

h. Do you have access to any tools or methods which are intended to help you in your management function but which you don't use?

i. What tools or methods would you like to have to do your management function?

develop
evaluate
update

j. Do you foresee any future occurrences or events which will impact training management?

k. Are there any other problems in management we have not already discussed?

l. Where do you see the highest payoff with regard to the use of tools/methods in training management?

(RESOURCE PLANNING ONLY)

m. What tools or methods do you currently use to:

-- manage shared resources?
-- identify resources requirements?
-- evaluate training capacities?
-- estimate TDY travel for students?
-- prioritize training requirements?

n. Other persons who we should talk to?

2. Is there adequate time available for your training at the

-- unit?
-- FTD?
-- MAT?

No:

a. What are the factors limiting your availability for training?
b. How do these factors impact the quality of training?

3. Does your training load keep you away from your unit's mission?

   Yes

   a. What types of training are impeding performance of your unit's mission?
   b. How do they impede performance of your contribution to the unit's mission?

4. Are trainers (i.e., instructors) typically available to conduct training when training is needed?

   No:

   a. Why?
   b. How does this impact the quality of training?
   c. How would you like training to be delivered?

5. Are the necessary resources, such as training materials, equipment, facilities, available for your training?

   No

   a. Why?
   b. To what degree does this affect training?
   c. What types of resources are typically not available for training?
   d. What resources do you need for training?

6. Do you know which tasks or topics you require training on?

   -- job tasks?
   -- ancillary?

   a. Is this information available to you?
   b. Is this information helpful to you?
   c. In what format do you receive this information?
   d. In what format would you like to receive this info.?

7. Are you generally satisfied with training management?

D. Evaluations

"These next questions focus on evaluations. This includes evaluation of students, training courses, and the training system itself."

1. Are you involved in evaluations?

   Yes

   a. Function?

      ___ student evaluations
      ___ course evaluations
      ___ system evaluations

   b. What specific products or services do you provide with regard to your evaluation function?

      EX: OPR for regulations
      news letters
      reports

   c. Do you interact with any other organizations or individuals when performing your evaluation function?

   d. What information do you use in your evaluation function?

   e. What information would you like to have for your evaluation function?

   f. Do you have any structured procedures for your evaluation function?

      EX: regulations
      locally prescribed procedures

   g. What tools or methods do you currently use to accomplish your evaluation function?

   h. Do you have access to any tools or methods which are intended to help you in your evaluation function but which you don't use?

   i. What tools or methods would you like to have to do your evaluation function?

j. Do you foresee any future occurrences or events which will impact training evaluation?

k. Are there any other problems in evaluation we have not already discussed?

l. Where do you see the highest payoff with regard to the use of tools/methods in training evaluations?

m. Other persons who we should talk to?

2. Do evaluations impact the type of training an individual receives?

3. Are tasks or topics with greater mission importance given greater weight in evaluations?

4. What is used to evaluate training requirements for incoming personnel?

5. Do you feel that evaluations (i.e., knowledge tests and performance tests) fairly reflect what you have been taught or what you teach?

No:

a. What do you think is wrong with current evaluations?
b. How should evaluations be conducted?

6. Are you generally satisfied with training evaluations?

E. Development/Delivery

"These remaining questions focus on the development and delivery of training within your unit. Development and delivery includes all activities concerned with authoring and delivering instruction such as training needs assessment, curriculum development, identification of delivery methods, and delivering instruction."

1. Are you involved in the development of training?

Yes

a. Function?

___ training development

___ method selection

b. What specific products or services do you provide with regard to your development/delivery function?

EX: OPR for regulations
news letters
reports

c. Do you interact with any other organizations or individuals when performing your development/delivery function?

d. What information do you use in your development/delivery function?

e. What information would you like to have for your development/delivery function?

f. Do you have any structured procedures for your development/delivery function?

EX: regulations
locally prescribed procedures

g. What tools or methods do you currently use to accomplish your development/delivery function?

develop
evaluate
update

h. Do you have access to any tools or methods which are intended to help you in your development/delivery function but which you don't use?

i. What tools or methods would you like to have to do your development/delivery function?

develop
evaluate
update

j. How do you determine the level to which an objective is taught?

k. How do you determine where to teach a particular task?

l. Do you foresee any future occurrences or events which will impact training development and delivery?

m. Are there any other problems in development and delivery we have not already discussed?

n. Where do you see the highest payoff with regard to the use of tools/methods in development and delivery?

o. Other persons who we should talk to?

2. Do you feel that you are adequately trained to do your job by the

-- unit?
-- MAT?
-- FTD?

No

a. How does this impact your job?
b. Where should this training occur?

3. Are trainers in your unit adequately prepared to act as teachers/instructors, i.e., do they teach well?

-- at FTDs?
-- at MATs?

No

a. Why?

4. Do you train anyone?

Yes:

a. What do you train?
b. How are you trained or qualified as a trainer?
c. Do you feel that you are qualified to train others?
d. What is your training workload?
e. Does this duty keep you away from your primary job?
f. How does this impact your job performance?
g. Are additional personnel needed?

h. Do you feel that you have adequate time to train your trainees?

No

1) How does this impact training quality?

2) How does this impact the trainee's job performance?

3) How does this impact unit performance?

5. What media are used in your unit level training programs?

__ Lecture/Presentation
__ Overhead
__ CAI
__ Sound on Slide
__ Video Tape
__ IVD
__ Text
__ Hands-on
__ Other

6. On a scale of 1 to 7 with 1 being very seldom, 7 being very often, and 4 being average, how often is each of the media you identified used in job training?

1----2----3----4----5----6----7		
Very Seldom	Avg	Very Often

__ Lecture/Presentation
__ Overhead
__ CAI
__ Sound on Slide
__ Video Tape
__ IVD
__ Text
__ Hands-on
__ Other

7. On a scale of 1 to 7 with 1 being very seldom, 7 being very often, and 4 being average, how often is each of the media you identified used in ancillary training?

1----2----3----4----5----6----7
Very Seldom — Avg — Very Often

___ Lecture/Presentation
___ Overhead
___ CAI
___ Sound on Slide
___ Video Tape
___ IVD
___ Text
___ Hands-on
___ Other

8. Are the training media you identified readily accessible?

No:

a. Which media are not readily accessible?

b. Why?

9. How would you assess the reliability of the equipment used for each of these media on a scale 1 to 7 with 1 being very unreliable, 7 being very reliable, and 4 being average? (i.e., does the equipment typically work or not?)

1----2----3----4----5----6----7
Very Unreliable — Avg — Very Reliable

___ Lecture/Presentation
___ Overhead
___ CAI
___ Sound on Slide
___ Video Tape
___ IVD
___ Text
___ Hands-on
___ Other

10. How would you assess the relative training effectiveness of the training you receive from each of these media on a scale 1 to 7 with 1 being very ineffective, 7 being very effective, and 4 being average?

1----2----3----4----5----6----7
Very Ineffective — Avg — Very Effective

___ Lecture/Presentation
___ Overhead
___ CAI
___ Sound on Slide
___ Video Tape
___ IVD
___ Text
___ Hands-on
___ Other
___

11. Do you feel that your training adequately prepares you for your job?

No:
    a. Why?

12. Do you feel that the training technologies you use today adequately train what they are intended to train?

No:

    a. Why?

13. Do you have access to any tools or methodologies today which you don't use for training?

Yes:

    a. What are they?
    b. Why don't you use these tools or methodologies?

14. What tools or methods would you like to have for training purposes?

    a. What features are you looking for in these tools or methods?
    b. Do you have the resources to support these tools or methods?

15. Where do you see the highest payoff with regard to the use of tools or methods in training?

16. Are you generally satisfied with the development and delivery of training?

F. General Problems

1. What particular strengths and limitations in the quality of graduates from technical school have been noted by your unit(s)?

2. Do technical schools train maintainers in the areas you want them to?

3. Are technical schools overtraining in any areas?

4. Are technical schools undertraining in any areas?

5. What is the average time required for an incoming 3-level to become position qualified in your unit(s)?

   -- for an incoming experienced maintainer?

6. How does personnel turnover in the unit influence mission performance?

7. Is the level of maintainer experience declining?

   Yes:

   a. What are the primary effects upon the unit?
   b. What are the primary factors contributing to the decline?
   c. What alternatives are available to off-set these effects?

8. Have you encountered any other problems in training that we have not already discussed?

   Yes:

   a. What are they?
   b. How do they impact training?

9. Are you generally satisfied with the training process?

10. What changes should be made?

   a. How can tools or methods support this?

11. Do you foresee any future events or occurrences that might impact the training process in the future?

Yes

a. What are these events or occurrences?
b. What will their impact be?

12. How do you see training being conducted in

a. the near term?
b. the long term?

APPENDIX D: DATA ANALYSIS/SUMMARY

This Appendix contains a series of tables which detail the interviewees' response to many of the survey questions. For each question, the total number of those responding to the question is listed. Note that the respondent sample sizes vary from question to question. This was to be expected since not all of the questions were asked of each interviewee nor did all of the interviewees give responses to every question. It should also be pointed out that the responses from each group interview were aggregated and reduced to a single data point for each response. In this manner, a group of five is not weighted more heavily than a group of three or an individual interview. All of the survey questions included in this Appendix allowed for more than one response. Thus, the total number of responses can exceed the sample size. The frequencies reported for these items can be interpreted as "the number of individuals and/or groups giving that particular response." Percentages can be interpreted similarly. Each table contains a footnote reminding the reader that respondents were not restricted to one response.

Table D-1. Types of Training Requirement Diagnostics for Incoming Personnel (Question D4); N = 75.

Diagnostic Cited	Frequency[a]	Percent
Initial interview	68	91
Records review (623, 797, etc.)	44	59
Over-the-shoulder evaluations	26	35
Computer RIPs (CAMS, CASB, MMICS, Personnel)	16	21
Written test	2	3
Training rosters	1	1
Peer group assessment	1	1
Rivet Workforce core task list	1	1

[a] Multiple responses allowed.

Table D-2. **Decline of Maintainer Experience.**

Factors Contributing to Decline of Maintainer Experience (Question F7); N = 50.

Factor Cited	Frequency[a]	Percent
Excessive turnover	29	58
Ineffective (or lack of) training	15	30
Rivet Workforce policies have diluted experience.	15	30
Too much cross-command/weapon system movement	15	30
Early out program has depleted experience	6	12
Force drawdown	6	12
High year of tenure has depleted experience levels	6	12
The Enlisted Performance Rating system has forced out good people.	2	4

[a] Multiple responses allowed; 60 personnel responded that experience was on the decline.

Alternatives Available to Offset Decline in Maintainer Experience (Question F7); N = 35.

Alternative Cited	Frequency[a]	Percent
Change the personnel policies	24	69
More enroute training	11	31
Better training	11	31

[a] Multiple responses allowed.

Table D-3. Technical Training School Comments.

Strengths and Limitation of Technical School Graduates (Question F1); N = 115.

Strength or Limitation Cited	Frequency[a]	Percent
Generally good quality of graduates	42	37
Some academic deficiencies (AFSC-specific)	31	27
Some weakness in basic skills/knowledge	20	17
No/limited contact with recent graduates	18	16
No trends have been noticed	11	10
Graduates are well disciplined/motivated	9	8
Graduates lack military courtesy/discipline	5	4
Graduates display a negative attitude	3	3
Graduates are confident	1	1
Graduates display a positive attitude	1	1

[a] Multiple responses allowed.

Areas of Overtraining in Technical School (Question F3); N = 19.

Response	Frequency[a]	Percent
Yes, (AFSC specific example)	13	68
Yes, the school is too weapon system specific	7	37

[a] Multiple responses allowed.

Table D-3 (cont).

Areas of Undertraining in Technical School (Question F4); N = 56.

Type of Training Cited	Frequency	Percent[a]
Yes, Basic systems knowledge	24	43
Yes, hands-on skills	21	38
Yes, (AFSC-specific example)	14	25
Yes, Technical Order use	8	14
Yes, troubleshooting	8	14
Yes, safety	2	4
Yes, maintenance management (forms, MDC, etc.)	1	2

[a] Multiple responses allowed.

Table D-4. **Types of Training Not Needed.**

Job/Ancillary Training Not Needed (Question A2); N = 41.

Type of Training	Frequency[a]	Percent
Hangar/Arch Door Operation	10	24
Egress	7	17
Block Training	6	15
Protection of the President	5	12
Aircraft FOD	4	29
Block training (not relevant to AFSC)	4	29
Drug/Alcohol Abuse	4	29
Ancillary	3	7
Code of Conduct	3	7
Flightline Driving	3	7
Social Actions	3	7
AGE Operator	2	5
CPR	2	5
External Fuel Tanks	2	5
Fire Safety	2	5
Standards of Conduct	2	5
Tech School	2	5
ABDR (Aircraft Battle Damage Repair)	1	2
Aircraft Corrosion	1	2
Aircraft Forms	1	2
Block Training refresher	1	2
Chemical Suit	1	2
CUT	1	2
Equipment Custodian	1	2
FTD Qualification (Phased)	1	2
Hazardous Communication	1	2
Hazards of F-16 Aircraft	1	2
Pallet Buildup & Marking	1	2
Self Aid & Buddy Care	1	2
Task Qualification (TQT)	1	2
Tech Orders/Data	1	2
Job-Related	1	2
Flightline	1	2
M-16	1	2

[a] Multiple responses allowed; 83 replied that training is being conducted as required.

Table D-4 (cont).

Reasons Why Training is Not Needed (Question A2); N = 40.

Reason Cited	Frequency[a]	Percent
Not relevant to AFSC/job	39	98
Do it frequently on the job	10	25
Depends on skill level or experience	7	18
Quality of training is not adequate	6	15
Task too simple or not critical	5	13
Duplicated in other training programs	3	8
Learned on-the-job before attending class	3	8
Never do it on the job	2	5
Is contrary to what is practiced	1	3

[a] Multiple responses allowed.

Table D-5. **Areas of Overtraining.**

Topics or Tasks Overtrained (Question A3); N = 50.

Type of Training	Frequency[a]	Percent
Block Training	12	24
Chemical Suit	10	20
Security	7	14
Drug/Alcohol Abuse	6	12
Egress	5	10
Protection of the President	4	8
Fire Safety	3	6
Flightline Driving	3	6
FOD	3	6
Self Aid & Buddy Care	3	6
AFSC-specific portions of Block Training	2	4
Aircraft Corrosion	2	4
Ancillary	2	4
Chafing	2	4
Social Actions	2	4
Standards of Conduct	2	4
AGE Operator	1	2
CASB	1	2
Code of Conduct	1	2
CPR	1	2
External Fuel Tanks	1	2
Flightline	1	2
Initial/Qualification	1	2
Integrated Combat Turn	1	2
Job-Related	1	2
OJT Trainer/Supervisor	1	2
Task Qualification (TQT)	1	2

[a] Multiple responses allowed; 73 replied that no tasks or topics are overtrained.

Table D-5 (cont).

Reasons for Overtraining (Question A3); N = 46.

Reason Cited	Frequency[a]	Percent
Training is redundant/done too frequently	35	76
Do it often enough to maintain proficiency	19	41
Depends on skill level or experience	12	26
The training is not good (quality of instruction, realism)	7	15
Task is simple or not critical	2	4

[a] Multiple responses allowed.

Table D-6. Types of Training Needed.

Job/Ancillary Areas Not Trained, but Needed (Question A4); N = 53.

Type of Training	Frequency[a]	Percent
FTD Qualification (Phased)	12	23
CAMS	7	13
Enroute	5	9
CASB	4	8
CPR	4	8
Electrostatic Discharge	3	6
M-16	3	6
AGE Operator	2	4
Cross Cultural Communication	2	4
Hydraulics	2	4
Job-Related	2	4
Refresher Training of infrequent tasks	2	4
Rivet Workforce	2	4
Safety	2	4
Aircraft Familiarization	1	2
Aircraft Forms	1	2
CTK Accountability	1	2
Fire Safety	1	2
Flightline Driving	1	2
Gun Boresight	1	2
Hydrazine Hazard/Response	1	2
Instructor	1	2
Jet Fuel Starter	1	2
LOX/LIN Carts	1	2
Management	1	2
Pallet Buildup & Marking	1	2
Rigging of Flight Control Systems	1	2
Special Tools	1	2
Task Qualification (TQT)	1	2
Troubleshooting	1	2

[a] Multiple responses allowed; 71 replied that no additional training is needed.

Table D-6 (cont).

Reasons Training is Not Conducted (Question A4); N = 46.

Reason Cited	Frequency[a]	Percent
Training is not offered	39	85
Qualified instructor not available	15	33
No time available	2	4
Training facilities, equipment, materials not available	2	4

[a] Multiple responses allowed.

Table D-7. Areas of Undertraining.

Topics or Tasks Undertrained (Question A5); N = 64.

Type of Training	Frequency[a]	Percent
Self Aid & Buddy Care	14	22
Chemical Suit	13	20
CPR	13	20
CAMS	10	16
Troubleshooting	10	16
AGE Operator	7	11
Disaster Preparedness	6	9
Fire Safety	5	8
Borescope	4	6
Job-Related	4	6
Rivet Workforce	3	5
Ancillary	2	3
Component Change	2	3
Drug/Alcohol Abuse	2	3
OJT Trainer/Supervisor	2	3
Refresher Training of infrequent tasks	2	3
Safety	2	3
ABDR (Aircraft Battle Damage Repair)	1	2
Block training (not relevant to AFSC)	1	2
Block Training	1	2
CUT	1	2
Electrostatic Discharge	1	2
Enroute	1	2
Flightline Driving	1	2
FTD Qualification (Phased)	1	2
Gun Boresight	1	2
Hands-on	1	2
Hangar/Arch Door Operation	1	2
Hydrazine Hazard/Response	1	2
Initial/Qualification	1	2
Instructor	1	2
Integrated Combat Turn	1	2
Security	1	2
Social Actions	1	2
Standards of Conduct	1	2
Tech Orders/Data	1	2
Tech School	1	2

[a] Multiple responses allowed; 58 replied that no topics or tasks are undertrained.

Table D-7 (cont).

Reasons for Undertraining (Question A5); N = 49.

Reason Cited	Frequency[a]	Percent
Task is important/critical	37	76
Need hands-on training	20	41
Not enough intensity or realism	19	39
Not enough time	17	35
Qualified instructor not available	4	8
Task is complicated/difficult	2	4
Facilities, equipment, materials not available	2	4

[a] Multiple responses allowed.

Table D-8. Types of Feedback Mechanisms (Question B3); N = 91.

Feedback Mechanism	Frequency[a]	Percent
Course critiques	58	64
Informal coordination between training agency and user	43	47
Training Evaluation Reports (TER)	25	27
Training Quality Reports (TQR)	22	24
Local questionnaires/surveys	9	10
Training meetings/conferences	9	10
ECI Form 17	6	7
AMQP QA Reports	5	5
Suggestion Box	2	2
U & T Workshops	1	1

[a] Multiple responses allowed.

Table D-9. Instructor Qualifications.

Training/Qualification to Serve as Instructor (Question EB4); N = 55.

Qualification	Frequency	Percent[a]
OJT Trainer/Supervisor Course (FTD)	28	51
On-the-job instructor experience only	12	22
Other military instructor training	10	18
ATC Technical Instructor Course	7	13
Civilian education/training/experience	1	2
Subject matter training/certification/ experience	1	2
PME	1	2

[a] Multiple responses allowed.

Training/Qualification to Serve as Instructor (Question EB4): OJT Trainers; N = 22.

Qualification	Frequency	Percent[a]
OJT Trainer/Supervisor Course (FTD)	12	55
On-the-job instructor experience only	8	36
Other military instructor training	5	23
ATC Technical Instructor Course	1	5
Civilian education/training/experience	1	5
Subject matter training/certification/ experience	1	5

[a] Multiple responses allowed.

Table D-10. Needed Training Technologies.

Types of Training Tools or Methods Requested (Question E14); N = 49.

Response	Frequency[a]	Percent
IVD	23	47
CAI	12	24
Mock-Up/simulator	9	18
Video (local production capability)	7	14
Updated training materials	3	6
Classrooms	2	4
Yes, methods needed but not designated	2	4
System schematics	1	2

[a] Multiple responses allowed.

Desirable Features of Training Tools or Methods (Question E14); N = 31.

Feature Cited	Frequency[a]	Percent
Aid to training difficult tasks (e.g., troubleshooting)	15	48
Allow for hands-on skill development	8	26
Easy to use	6	19
Flexible	6	19
Convenient	5	16
Realistic	5	16
Self-paced	4	13
Interactive	4	13
Easily updated	2	6
Standardized	2	6
Understandable	2	6
Minimum documentation required	1	3

[a] Multiple responses allowed.

Table D-11. **Limiting Factors.**

Factors Limiting Unit Training (Question C2); N = 47.

Factor Cited	Frequency[a]	Percent
Mission requirements/operational commitments	40	85
Lack of emphasis on training	10	21
Availability of trainers/trainees	8	17
Manning levels	7	15
Lack of qualified instructors	3	6
Lack of prerequisite qualification training	3	6
Training is not conducted/offered	2	4

[a] Multiple responses allowed.

Factors Limiting FTD Training (Question C2); N = 9.

Factor Cited	Frequency[a]	Percent
Lack of qualified instructors	5	56
Availability of trainers/trainees	1	11
Lack of emphasis on training	1	11
Manning levels	1	11
Mission requirements/operational commitments	1	11
Lack of prerequisite qualification training	1	11
Training is not conducted/offered	1	11

[a] Multiple responses allowed.

Factors Limiting MAT Training (Question C2); N = 3.

Factor Cited	Frequency[a]	Percent
Mission requirements/operational commitments	2	67
Manning levels	1	33
Training is not conducted/offered	1	33

[a] Multiple responses allowed.

Table D-12. Effects of Personnel Turnover.

Effects of Personnel Turnover on Mission Performance (Question F6); N = 103.

Effect Cited	Frequency[a]	Percent
It extends the training/qualification time	37	36
It impacts training (OJT) continuity	35	34
It has little or no influence	20	19
People PCS as soon as they are trained	15	15
It has influence but no reason specified	13	13
It influences people's attitude	9	9
Since there is no time for training, specialize in what they know	8	8
It influences the mission most at the peak times (e.g., summer, holidays)	2	2

[a] Multiple responses allowed.

Effects of Turnover on the Unit (Question F7); N = 48.

Effect Cited	Frequency[a]	Percent
Quality of OJT declines	35	73
Quality of maintenance declines	19	40
More time required for maintenance	10	21
Morale suffers	5	10
Increased training burden	5	10
Quality of Force suffers	3	6

[a] Multiple responses allowed.

Table D-13. **Training Transfer Issues (Away from the Unit).**

Unit Training that Could be Conducted Elsewhere (Question A6); N = 38.

Type of Training	Frequency	Percent[a]
AGE Operator	9	24
Hazardous Communication	7	18
FTD Qualification (Phased)	6	16
Flightline Driving	5	13
Rivet Workforce	5	13
Self Aid & Buddy Care	5	13
CPR	3	13
Fire Safety	2	5
Ancillary	1	3
Chemical Suit	1	3
Component Change	1	3
Conversion	1	3
Egress	1	3
Electrostatic Discharge	1	3
External Fuel Tanks	1	3
M-16	1	3
Refresher Training of infrequent tasks	1	3
Security	1	3
Task Qualification (TQT)	1	3
Tech Orders/Data	1	3
Towing	1	3
Troubleshooting	1	3

[a] Multiple responses allowed.

Sites for Training (Question A6); N = 38.

Location Cited	Frequency	Percent[a]
FTD	15	39
MAT	14	37
Tech School	12	32
Wing	6	16
AGE Shop	5	13
Hospital	4	11
Enroute	3	8

[a] Multiple responses allowed.

Table D-13 (cont).

Reasons for Transferring Training (Question A6); N = 22.

Reason Cited	Frequency[a]	Percent
Qualified instructor not available in unit	22	100
Need to be able to do immediately on the job	6	27
Training needs to be standardized	6	27
Don't have time	4	18
Important/complex enough for formal training	4	18
Work environment not conducive to training	3	14
Facilities, equipment, materials not available	1	5

[a] Multiple responses allowed.

Table D-14. Training Transfer Issues (To the Unit).

Training that Should be Conducted at the Unit (Question A7); N = 48.

Type of Training	Frequency[a]	Percent
Hangar/Arch Door Operation	9	19
Fire Safety	9	19
CAMS	8	17
CPR	8	17
Self Aid & Buddy Care	6	13
Block Training	5	10
Egress	5	10
Chemical Suit	4	8
AGE Operator	3	6
Chafing	3	6
Towing	3	6
AFSC-specific portions of Block Training	2	4
FOD	2	4
CASB	2	4
Hazardous Communication	2	4
Tech School	2	4
Code of Conduct	1	2
Electrostatic Discharge	1	2
Initial/Qualification	1	2
Safety	1	2
Standards of Conduct	1	2

[a] Multiple responses allowed.

Table D-14 (cont).

Reasons for Transferring Training to the Unit (Question A7); N = 44.

Reason Cited	Frequency[a]	Percent
Training should to be tailored to unit needs	37	84
Unit personnel are most qualified to teach it	12	27
Allows flexibility in scheduling training	8	18
Lose people from work longer than necessary	7	16
Ease of administration	6	14
Task difficulty does not justify formal class	5	11
Training needs to be hands-on	3	7

[a] Multiple responses allowed.

Table D-15. Training Importance Ratings.

Type of Training	1/3 Level Mean	SD	N	5 Level Mean	SD	N	7 Level Mean	SD	N
				ANCILLARY					
Chem Suit	4.35	.91	209	4.21	.91	218	4.03	1.13	201
Fire Safety	4.47	.75	208	4.22	.88	216	4.06	1.10	199
Age Operator	3.60	1.23	204	3.57	1.09	211	3.26	1.29	194
Block Trng	3.96	1.19	207	3.47	1.18	215	3.20	1.31	197
Hangar Door Operation	3.02	1.36	203	2.96	1.26	211	2.80	1.32	194
CPR	4.15	1.02	209	4.18	.99	216	4.17	1.00	198
Self-Aid/ Buddy Care	4.30	.91	211	4.18	.93	218	4.13	1.02	200
Security, COMSEC, OPSEC	4.35	.91	211	4.20	.89	218	4.16	1.04	200
Flightline Driving	3.46	1.39	209	3.73	.99	217	3.70	1.12	199
Drug/Alcohol Abuse	4.13	1.02	210	3.82	1.10	217	3.71	1.21	199
Soc Actions	3.67	1.12	209	3.46	1.09	216	3.45	1.20	198
Disaster Prep.	3.99	1.04	210	3.89	.98	217	3.89	1.12	199
Standards of Conduct	4.14	.96	210	3.84	1.02	217	3.78	1.21	199
Protection of President	3.63	1.34	208	3.54	1.34	216	3.49	1.34	198
Code of Conduct	3.91	1.14	210	3.71	1.15	217	3.66	1.22	199

Table 15 (cont).

Training Importance Ratings

Type of Training	1/3 Level Mean	SD	N	5 Level Mean	SD	N	7 Level Mean	SD	N
				JOB-RELATED					
Initial/Qual	4.53	.79	202	4.14	.96	206	3.81	1.20	189
FTD (AMQP)	4.07	1.17	192	3.88	1.05	200	3.55	1.16	182
Continuation	3.91	1.10	198	3.88	.93	206	3.68	1.12	189
Requal	3.52	1.27	193	3.76	1.04	204	3.73	1.09	187
Conversion	3.34	1.42	187	3.69	1.14	196	3.71	1.19	180
CUT	2.60	1.39	182	3.14	1.26	191	3.21	1.29	175

Note. Ratings were on a scale of 1 (Not Important) to 5 (Extremely Important). Rating form (See Appendix C) was administered individually to each interviewee.

APPENDIX E: HSD TECHNOLOGIES

Current HSD Science

Advanced Instructional Design Advisor (AIDA) research is exploring the automation of an instructional design system which would guide course developers through the instructional design process. The system would be derived from empirically sound and theory-based instructional design model.

Advanced-On-the-Job Training System (AOTS) will integrate training development, delivery, evaluation, and management to provide an automated squadron-level technology for systematic and effective job-site training. The production version of this technology, the Base Training System (BTS), will be limited to the management functions of AOTS prototype.

Advanced Training System (ATS) is an integrated CBT and support system using distributed architecture for development, delivery, evaluation, and management of training at ATC resident technical training wings. Instructional development subsystems could be used for contractor-produced training systems which would then be exported to units. ATS has the potential to be the foundation for all CBT, simulators, and part-task trainers. Instructional development, delivery, management, and evaluation subsystems developed under this effort could be applied to SLT.

Aircrew Combat Mission Enhancement (ACME) will provide a low-cost method for defining multiship team training issues and problems. Remote Air Intercept Trainers could be networked to ACME for SLT. Basic Job Skills (BJS) is a type of intelligent tutor that can be used for training first term airman in high tech jobs. The goal is to train technicians who can adapt across generations of weapon systems and AFSCs. The training emphasizes general technical knowledge and skill and the importance of performance with understanding.

Basic Job Skills project is developing an integrated cognitive task analysis/training development technology to build adaptive training directed at the fundamental mental skills required in the AF's most technologically advanced enlisted occupations. The goal is to train the complex problem solving skills that accelerate the growth to competence and to knowledge flexibility in high-tech workcenters by capturing the collective maintenance savvy of expert technicians. The expert knowledge base is then transformed into learnable curriculum for novice technicians.

C-130 Aircrew Training System Evaluation (ATSE) will produce system evaluation methodology to help determine if future simulators are effective training devices. The methodology will measure pilot proficiency effected by the simulator.

Comprehensive Occupational Data Analysis Program (CODAP) is a package of computer programs used to input, process, organize, and report occupational data from job inventories. CODAP manipulates and reports task-level and biographical survey data gathered from job incumbents and expert raters for the purpose of identifying and analyzing current job structures and task characteristics within a target occupational area.

Computer-Based Training Selection and Implementation Strategies will explore, evaluate, and develop guidelines for selecting and applying CBT technologies to training. The products will guide training managers in selecting and converting existing courses into CBT systems.

Fundamental Skills Training (FST) research involves an assessment of those fundamental skills that airmen or recruits must possess if they are to succeed in the AF.

Instructional Support System (ISS) provides a government-owned software package for use in computer-based training and management. A user-friendly system hosted on a micro-computer, ISS would allow trainers at the squadron-level to develop CBT for their own use which can be transported to other units.

Integrated Maintenance Information System (IMIS) can be used to provide in-depth training for the maintenance technician through a portable digital text and graphics display job aid. This electronic job aid can be hand-carried to present the required information at the job site.

Intelligent Tutoring Systems (ITS) will provide effective, low cost, transportable training for individualized instruction in specific high technology areas. ITS authoring and delivery capabilities will result from the Intelligent Computer Assisted Training Testbeds project.

Job-Aided/Training Analysis Technologies (JATAT) will provide methods for deciding whether and how tasks should be trained, job-aided, or some combination of the two and provide human and system performance models to evaluate those decisions.

Job Performance Measurement (JPM) program is developing methods for measuring individual job performance to validate selection/classification tests, evaluate training systems/programs, and evaluate research products (e.g., tutors).

Logistics Command and Control focuses on the development of empirically-based integrated instructional methodologies for individualized instruction within the logistics command and control environment. Specifically, integrated approaches to provide self-paced instruction of prerequisite knowledges and skills, orientation and preliminary indoctrination to individual roles, and maintenance of proficiency for LC2 battle staffs. The LC2 program will develop an integrated instructional methodology and a prototype desktop trainer for the logistics battle staff environment.

Multi-Task Trainer Research (MTTR) is based on Air Intercept Trainer technology and will provide emergency procedure training in flight safety. It will have authoring capabilities so that non-programmers can quickly and easily modify course content to provide up-to-date training.

Part Task Trainers (PTTs) provide low cost, off-the-shelf, easily upgradeable simulator training systems. PTTs would permit frequent practice of mission critical tasks at the squadron level.

Task Analysis for Tactical C2 (TATC2) will provide knowledge engineering methodologies for command and control domains. This will alleviate some of the problems associated with developing new training systems.

Training Assessment Technologies can provide methods for developing measures of job knowledge and performance which can be used to identify training needs and evaluate training programs and individual's performance. One example is the evaluation of ATC/TAC 4-level training program.

Training Decision Modeling Technologies (TDMT) will allow training managers to make better decisions about the what, when, and where of training. Decisions could be made that focus on the squadron-level training needs.

Training System for Maintenance (TRANSFORM) will be used by Instructional Systems Developers in developing maintenance training for new weapon systems. The TRANSFORM products will be used by Field Training Detachments. The system, which provides an automated interface between the Logistics Support Analysis process and Instructional Systems Development, is being used as a prototype in a Joint Service Decision Support System.

Related HSD Technologies

3-Dimensional Audio research explores technology that can project sound in a three dimensional space using a headset and the implications of human abilities to localize that information. With future development, this technology could be applied as an output technique in computer-based training systems deployed at the unit level. (AAMRL/BB)

Air Crew Selection research continues to develop high performance skill assessment techniques that potentially could be applied to the assessment of an individual's skill level as the student progresses through high performance training. (AL/HRMO)

Aircraft Mishap Prevention related research is developing an integrated database and analysis system for processing mishap-related information. This system can be used for rapid dissemination of mishap prevention information to networked units. (HSD/YA)

B-1B Engineering Research Simulators efforts will derive human factors principles on human-machine interactions which may have implications for simulators and other computerized training systems. (AAMRL/HE)

Cockpit Automation Technology (CAT) can contribute to SLT by providing engineering design tools which would be used in the rapid prototyping of high fidelity simulations. Research on simulation validation techniques may also contribute to the development, delivery, and evaluation of SLT systems. (HSD/YA)

Command, Control, Communication (C3) research can facilitate the development of realistic mission environment simulations. These simulations can be used to train team decision-making and other team related activities. Human-computer interaction in computer-based training systems may be improved by the research efforts in C3. (AAMRL/HE, AL/HRL)

Duodecahedron Screens with back-project video around a cockpit development offers relatively low-cost flying simulations. This technology has the potential to be deployed at unit training centers. (AL/HRA)

Human Performance in Simulations research studies various effects on human performance in simulators. Investigations include exploring transfer of training across simulators, effects of simulator performance (e.g., timing delays) on human performance, and the role of visual cues in low-level flying. (AAMRL/HE)

Integrated Perceptual Information for Designers (IPID) efforts produced reference materials on human performance specifications relevant to system design. These materials have implications for simulation development. (AAMRL/HE)

Learning Abilities Measurement Program (LAMP) conducts research on human learning, memory, and problem solving abilities. The outcomes of this research provides data, principles, and theory concerning human learning that can be embedded in SLT systems. (AL/HRMO)

Low Fidelity Helmet development efforts provide a low-cost alternative to high-cost fiber optic helmets. These developments can be applied to virtual world applications, simulators, and computer-based training systems. (AL/HRA)

Low Level Flying Trainer efforts have applied videodisc technology to teaching principles of low level flying training. This relatively inexpensive technology could be adapted for SLT. (AL/HRA)

Operator Workload Measurement research is designed toward developing techniques for measuring operator mental workload in complex tasks. These measurement techniques may be applied in the development, delivery, and evaluation of SLT systems. (AAMRL/HE)

Speaker Independent, Continuous Speech Recognition is a problem that plagues systems requiring natural human-to-machine interaction. Efforts within HSD are attempting to develop systems that recognize human speech without "training" that system first. Computer-based training systems will greatly benefit from advances in this field. (AAMRL/BB)

Super Cockpit research has the potential to enhance SLT delivery through its research on crew-cockpit interface technology (i.e., man-machine interface). This technology can be integrated into visual display devices to enhance flight training. (HSD/YA)

Virtual Man-Machine Interaction related projects are being conducted to explore virtual space simulators. Low-cost virtual worlds can be applied to training novices to fix technologically complex equipment in a virtual environment. This results in greater opportunities for training in "safe" environments. (AAMRL/HE)

HSD Specific Training Domains

In addition to conducting research relevant to SLT, HSD has unique expertise that can be tapped in the development of specific unit level courses. These courses include:

Aerospace Medical Education
Hazardous Material Management
Physiological Training
Occupational and Environmental Health

APPENDIX F: DEFINITIONS OF ISD PROCESSES

ANALYZE SYSTEM REQUIREMENTS

1. Training Needs Assessment

   a. Analyze Situation. Determine whether or not a training/education option is appropriate.

   b. Identify Parameters. Identify operational requirements and constraints, design drivers, and system selection criteria.

2. Define/Analyze Job Performance Requirements

   a. Develop Task Listing. Describe what people must do to perform their jobs in terms of tasks, subtasks and activities.

   b. Analyze Job Tasks. Identify the skills, knowledges, proficiency levels, and supporting competencies required by the target population for successful accomplishment of the job.

   c. Estimate Target Population Characteristics. Survey or estimate the skills, knowledges, and supporting competencies of the target population.

DEFINE EDUCATIONAL TRAINING REQUIREMENTS

1. Select Job Tasks Requiring Training. Examine each task to determine if it requires training.

2. Determine Student Prerequisites. Determine the prerequisite skills, knowledges and supporting competencies required of individuals entering training for each task.

3. Select Appropriate Training Setting. Determine the appropriate type of training setting (i.e., resident course, field training, OJT, mobile training team, correspondence, job aid).

4. Estimate Resource/Logistic Requirements. Estimate facilities, equipment, funding (including development and O&M), and personnel requirements.

DEVELOP OBJECTIVES AND TESTS

1. Develop Objectives. Describe observable behavior, minimum standards of performance, or proficiency expected, and the conditions under which the behavior is to be exhibited.

2. Develop Tests. Develop tests to measure achievement under the conditions and standards specified by the objectives.

3. Develop Job Performance Testing Standards. Describe the procedures to be used by the evaluators when evaluating job performance.

PLAN, DEVELOP & VALIDATE INSTRUCTION

1. Plan Sequence of Instruction. Arrange sequence of learning objectives so that prior learning becomes the context or acquisition of new knowledge.

2. Select Instructional Method

   a. Evaluate Alternative Instructional Methods. Evaluate alternative course design strategies, teaching models and methods, and evaluation strategies against the type, kind and level of training and student performance anticipated.

   b. Identify Instructional Method. Identify the way by which instruction will be designed, structured, and evaluated.

   c. Establish Detailed Course Design. Organize instructional events (e.g., gaining attention, informing learner of the objective, stimulating recall of prior knowledge, presenting stimulus material, providing feedback, etc.) to support learning processes.

2. Select Instructional Media

   a. Evaluate Candidate Media. Survey capabilities of candidate training technologies or media and compare to system criteria.

   b. Select Instructional Media. Identify the means by which the instruction will be delivered to learners (e.g., interactive video, computer, lecture, books, etc.)

   c. Develop system specification. Define and analyze a complete set of functional, interface, and performance requirements for the instructional system.

3. Determine Resource and Funding Requirements. Determine facility, equipment, personnel and funding requirements for instruction.

4. Develop Instructional Materials

   a. Author Instructional Materials. Prepare lesson specifications, script lessons, layout Storyboards for each lesson and test, and edit scripts, storyboards, lesson flow diagrams, etc.

   b. Produce Instructional Materials. Develop instructional products, such as videos, computer programs, and simulations, based on lesson specifications

5. Validate Instructional Materials

   a. Review Courseware Prototype. SME and ISD review of courseware prototypes, lessons and test specifications, storyboards, layouts, art etc.

   b. Individual student tryouts of instruction. Pretest instructional material on selected individuals.

   c. Small group tryouts of instruction. Pretest instructional material on selected small groups.

6. Validate Complete System. Try out instructional material on a sample of students who are representative of the total target population.

E. CONDUCT AND EVALUATE

   1. Deliver Instruction. Present instructional materials according to the strategy and media selected.

   2. Support Instruction

      a. Schedule students. Ensure students are scheduled for required training in a timely manner.

      b. Schedule resources. Provide for resources to support operation of the instructional system, including equipment, lesson materials, instructors and supervisors.

      c. Track student progress. Monitor students to determine where they are in their training program, where they should be, and what has to be done to get them there.

      d. Manage training requirements. Ensure that training requirements reflect those tasks, skills and knowledges which people must know to do their jobs and which require training.

e. Maintain and update instructional system. Provide for maintenance and currency of instructional system.

3. Evaluate Instruction

   a. Evaluate internal validity of instructional product (student performance). Assess effectiveness of an instructional program in terms of student performance.

   b. Evaluate external validity of instructional product (job performance). Assess effectiveness of an instructional program in terms of performance on the job.

   c. Measure training system utility and cost-benefit. Assess the effectiveness of the instructional program in light of its cost.

APPENDIX G: CRITERIA FOR EVALUATION OF TRAINING TECHNOLOGIES

A key component of the SLT research initiative is the assessment of HSD training technologies for their potential usefulness at the unit level. These technologies are to be assessed at some future point to allow Air Force decision-makers to prioritize R&D support for both existing and currently non-existent, but needed, technologies. The establishment of evaluative criteria is a preliminary stage required for advancement of a Science and Technology (S&T) Investment Strategy which will prescribe R&D activity in the area of training technology development. This Appendix will describe the identification and development of a set of proposed evaluative criteria and present strategies and sample instruments for gathering the data necessary to allow evaluation and prioritization of technologies. Finally, this appendix examines some potential benefits associated with enhanced SLT based on project manager inputs.

A. The Need For Criterion Development

In the current environment of constrained resources (i.e., funding, staffing, time), researchers and developers will likely be increasingly limited in the number of technologies that they can pursue in the development of new training systems. Therefore, it is of extreme importance that the "right" technologies be identified as early as possible in the development process. Important, too, is that efforts and resources be concentrated to apply the selected technology to the training need rapidly and economically.

To effectively operate in this environment, developers must have an effective set of standards, measures, or gauges by which they can evaluate the potential of a training technology. These measures become the "criteria" for evaluating the utility of the application of technologies to the various training needs. The use of the term "utility" has a number of connotations for researchers and evaluators. For this study, "utility" can be thought of as advantage, applicability, appropriateness, fitness, relevance, or usefulness. That is, the focus of evaluation is to assess the capability of or potential for technologies to meet identified training needs.

While little has been written by researchers on the development of criteria to be used for evaluation, a brief discussion of performance criterion development can be helpful (e.g., tests, ratings). With this related literature as a basis for the present effort (cf., Smith, 1976), guidelines for the evaluative criteria themselves can be extracted. For example, Bellows (1961) indicated that measures should be reliable, realistic, representative, predictable, relevant, acceptable to users, and consistent from one situation to another. Blum and Naylor (1968) specified that criterion measures should also be inexpensive, understandable, measurable, relevant, uncontaminated and bias-free, and discriminating. Thus, we have some general guidance and standards for the identification of criteria to be used for the evaluation of training technologies.

The following discussion identifies several criteria that have the potential for identification of those candidate technologies with the greatest potential of providing the desired training solutions (i.e., increasing training effectiveness and efficiency). However, it must be realized that these criteria cannot be identified and applied without parallel development of measurement procedures to ensure that diverse, valid organizational interests are properly identified and included in the evaluation process. As an example, field comments from the SLT interview process revealed that unit-level trainers are most interested in the development and delivery of new hands-on training technologies which supplement and enhance OJT. They are not concerned about state-of-the-art educational theories or technologies. Nor are they concerned with the planning/programming and management/evaluation domains of higher headquarters. They are concerned, however, with some management aspects such as record keeping, and want an input on determining what to train, when to train, and how best to train.

Thus, evaluative criteria and the associated measurement and weighting procedures must not only properly identify and reflect these unit-level concerns, but must do the same for the intermediate managers and planners, headquarters staff, and other concerned parties. The discussion of each criterion below will include suggestions for quantifying each criterion and for gathering data from the appropriate sources across organizational levels.

B. SLT Evaluative Criteria

Many evaluative criteria relevant to this project are conceptually related and interdependent (e.g., "efficiency" and "cost"; "acceptable" and "user-friendly"). For the purposes of selection of criteria here, however, it is important that each criterion be distinct from all others to allow for greater precision in analysis and interpretation of results. It is necessary that each criterion be clearly defined and operationalized for usage as intended by: (a) those subject-matter experts (SMEs) supplying criterion evaluation data; (b) researchers and decision-makers interpreting SME responses; and (c) researchers and decision-makers evaluating existing sources of technical data and other input (e.g., test results, records, evaluative study findings). The following section presents and defines each evaluative criterion, provides discussion of the rationale for inclusion, and proposes measurement tactics for collecting the necessary data.

The individual evaluative criteria are grouped under broad categories of either "Unit-Level User Acceptability" or "Management Acceptability." We believe that this general sorting of criteria helps to reflect the necessary duality of evaluative focus required for most R&D efforts and accurately depicts the multi-dimensionality of the "Acceptability" criteria (i.e., there are many contributors to the perception of acceptability). This two-sided view can be represented by the extreme case where "management" forces new procedures, gadgets, documentation, among others, on the work force at the unit level (i.e., the "users") without fully considering the necessity of the new technology from the users' point. Given that the two viewpoints have different concerns, it is essential that both be included in any evaluation of technologies designated for operational implementation. Some of the criteria listed below are relevant to only one source (i.e., user or management), whereas others are proposed for multiple sources to gather the widest possible range of valid input.

It is important to note that the current developmental stage of the various technologies to be considered will differ, reflecting their states of advancement. Thus, some of the data gathered will be somewhat speculative in nature, relying on incomplete data, reports, preliminary test findings, and so forth. Criteria requiring expert and/or user ratings will be based on judgments of prototype features, projected requirements, and planned procedures. The following criteria can be applied to new technologies across the range of developmental phases even though the type and, perhaps, validity of input data may vary.

Unit-Level User Acceptability

Criteria relevant to this concern reflect the likelihood that: (a) the unit will use the technology, (b) the unit will use the technology correctly, and (c) the users will see the technology as an asset with value for training at the unit level. Developers who do not take these criteria into consideration will likely fail to provide the user community with an effective technology.

Useability. This criterion reflects the convenience and ease of use of the technology. Included in this consideration would be the users' comprehension of instructions (i.e., understandability). There should be an absolute minimum of training and reading of instructions required to be able to use the technology, especially for those whose primary job is not training. Data should be collected from the users, including trainees and trainers, in the form of ratings of convenience and understandability. An analysis of reading level difficulty is an appropriate measure to be considered in the determination of useability. Additionally, an assessment measure or "test" of the comprehension of instructions and use of the technology could be developed and administered. This criterion is particularly important when the technology is hardware-oriented, involving sophisticated and/or novel equipment.

Practicality. The feasibility of integrating the training technology into the unit without interfering with mission is of key concern. Given that units frequently have sparse staffing and limited time for training, it is important that any new technology serve to ease the training requirement, not increase time demands. Thus, developers should be concerned that new technologies require few resources, including time, manpower, and support. Suggestions from maintenance personnel in the field included the notion that training tools could be modular in format to allow for intermittent use as time becomes available, and that technologies should not require excessive preparation or warm-up time. Minimal requirements for documentation of training and training results was a key concern of the field. Unnecessary or excessive paperwork is seen as a major detraction to the practicality of any proposed technology. The focus should be on the conduct of training, not its documentation.

Ratings from users and/or potential users would supply information relevant to practicality. These judgments could be obtained by supplying SMEs with information such as time required for training, resources requirements, and manpower support requirements, and then tasking them to make ratings of mission impact. With a format provided by Bierstedt, Gillet, and Bentley (1989) as a structure for practicality ratings, the following are examples of how this criterion could be operationalized. Managers would be presented with the following descriptions which they would then rate with the following mission impact scale. Note that lower ratings (i.e., 1 or 2) would indicate minimal or no mission impact and, hence, greater practicality.

1 = Not at all
2 = To a small extent
3 = To a moderate extent
4 = To a great extent
5 = To a very great extent

Example 1:

Given a training time of 20 hours and a requirement for portable computers, Technology X provides unit-level training on Ancillary Training Y. Will this Technology X negatively impact the mission?

___

Example 2:

Training Technology Z will train 3-skill level airmen on troubleshooting tasks A, B, and C. Training is modular in format, typically requiring 30-minute sessions. IVD equipment is required. Will Technology Z negatively impact the mission?

___

Example 3:

Management Technology J will allow shop supervisors to identify key tasks to serve as the basis for OJT during the upgrade period to the 5-skill level. This technology requires training of supervisors (40 hours in FTD), use of existing computers, frequent updates from MAJCOM, and monthly documentation and reports. Will Technology J negatively impact the mission?

Relevancy. Users are concerned that any time and technologies available for training be focused on critical, mission essential tasks. The training technology must address areas of need, that is, they must meet field requirements and not expend training resources on trivial or tangential aspects of the job. An additional requirement is that the technology must be available in a timely period; technological advancements that arrive in the field after their time frame for useful contributions has passed will be seen as irrelevant (e.g., "Why couldn't we have gotten this two years ago when we really needed it!").

Ratings of criticality of training content from projected users would be appropriate to address this issue. In a manner comparable to the Occupational Measurement Center's format of the Occupation Survey Report (OSR), career field specialists could provide Likert-type ratings of criticality, training emphasis, task difficulty, percent performing, and so on. As cited in the regulation for conducting occupational surveys, ATCR 52-22 (1986), AL/HR research has found that specialty members consider factors such as percent of members performing a task, average grade levels of personnel performing a task, and task criticality when making technical training emphasis ratings.

As an example of this general survey approach, the maintenance data collection portion of the SLT project gathered training criticality ratings. Each interviewee rated a series of ancillary and job-related tasks using the following scale:

1 = Not important
2 = Moderately important
3 = Important
4 = Very important
5 = Extremely important

This method could be used to assess SMEs' judgments of the relevancy of training content for any technology. It may even be possible to access existing OSR data relevant to the training content of each technology.

A question of who would provide the most valuable task criticality data must be addressed by researchers, and it may be appropriate to tap one or more skill levels to gather comprehensive data. Guidance for the conduct of Air Force occupational surveys describes how specialists at different skill levels provide different types of responses. They suggest, for example, that while 9-skill level specialists have extended work experience, they may be generally unfamiliar with current tasks. The best sources of job information are typically 7-skill level personnel since they possess years of job experience and perform both supervisory and technical tasks. Airmen at the 5-skill level provide the best task-specific information within a work center, but lack career ladder knowledge. Those at the apprentice, 3-skill level are usually highly familiar with a smaller number of job tasks and can provide input on simple or repetitive tasks and extra work details (e.g., work area clean-up, preparation for inspections, FOD walk). Thus, the selection of SMEs for evaluation of training technologies may include any or all of these career field members, dependent on the focus of the planned training.

Flexibility. An additional training needs requirement that can be evaluated is how well the training tools can incorporate job-related technological updates (e.g., changes to equipment and/or procedures). This criterion will reflect on the actual validity of the technology; that is, does it address a relevant concern or is it outdated and not useable? The face validity of the training is also affected since trainees are unlikely to react favorably or attend to training that is technically out-of-date, even when the basic principles are still valid. Consequently, the technology must be capable of maintaining credibility and currency through updates made in the field on an as-needed basis. Training technology developers can evaluate this aspect of the methodology and provide data to be considered by other evaluators. That is, the flexibility of the system or tool is best determined by the developers, although user input is also essential.

Components of the flexibility/"updateability" criterion could serve as the basis for a multiple-item assessment. Dimensions to be considered include: (a) requirements for technical task-specific data, documentation, technical orders, and so on; (b) format of these data (e.g., text, computer diskette); (c) methods and requirements for incorporating new data into the system; (d) expected frequency of future updates and changes; and (e) personnel requirements for making updates.

Reliability and Maintainability. Essential "ingredients" of a unit-level training technology include that it be reliable (i.e., works on a regular basis with little or no error) and require little or no maintenance (i.e., can withstand use and misuse of unit-level trainers and trainees). This criterion is primarily applicable for those training technologies that require extensive use of computer hardware/software or equipment. Dependable technologies are essential for unit-level users since it is not feasible for any central authority to monitor and maintain the technology; the users must be able to do this. Any technology that requires frequent and/or extensive maintenance in the field is unlikely to be effective or efficient since unit training resources should be devoted to training and not maintenance of technologies. While this is listed under "User Acceptability," developers should be able to provide test data and information relevant to this criterion. The ultimate tests are, however, actual user reports and empirical field data such as the reliability (Mean Time Between Failures [MTBF]) and maintainability (Mean Time to Repair [MTTR]) figures currently reported in monthly base level maintenance reports.

Enhances Hands-on Training. Consideration of this aspect of training technologies is somewhat related to the issues of relevancy. In this case, however, we are looking at relevancy of the purpose of training (i.e., complementing OJT) rather than the content of training (i.e., task criticality). Comments elicited by the SLT interview protocol indicated general concern at the unit level for technologies that will enhance hands-on training and be a complement to OJT. Hands-on training is seen by field personnel (e.g., OJT trainers, shop supervisors) as being the most valuable approach to insuring task competency and unit-level personnel are interested in improving its approach, making it a useful criterion for distinguishing between technologies. Evaluations by training technology developers can address the applicability of new tools to hands-on training.

Management Acceptability

For purposes of this report, we are defining "management" as those decision-makers above the unit level who are responsible for selecting, evaluating, and funding training technologies. It is important to consider functional managers and training system managers at all levels since different viewpoints can provide valid information related to the criteria discussed below. For example, personnel at the base/wing, Numbered Air Force (NAF), MAJCOM, and Headquarters USAF could be included as SMEs. Some of the criteria included in this general area of "Management Acceptability" are parallel to "Unit-Level User Acceptability," however, the content of the data is different, reflecting unique information relevant for evaluating the training technologies.

Criticality of Need. Managers have a broad view of mission requirements and should be able to provide input on current and projected training needs. They can make evaluations of the criticality of the training addressed by each training technology. They can also evaluate the appropriateness of the time frame of technology development and assess whether the scheduled development milestones will adequately meet training needs.

Practicality. The issue of practicality is also a relevant topic and concern for managers at various levels (e.g., base, MAJCOM, NAF, HQUSAF). They should be able to assess whether the technologies can be integrated into the unit without interfering with mission accomplishment. At a more global level (i.e., above that of the unit level), managers can also provide input as to the practicality and mission impact of the resource requirement data supplied by developers and program managers for each technology (e.g., funding, staffing, time).

Degree of Advancement. Perhaps the single-most important criterion relevant to the potential of a new training technology is its degree of advance or anticipated gain. Decision-makers will need to answer the question: Does the technology provide a detectable and meaningful improvement over existing capabilities?

This is the strict interpretation of the concept of "utility," that is, the extent to which a new technology improves upon existing capabilities. In this case, enhanced trainee performance over the current level is the most appropriate measure of gain. Various operational measures of performance include time to upgrade, Enlisted Performance Ratings, mission achievement measures (e.g., number of sorties, in commission rates, maintenance productivity), and so on. However, these may be insufficient to detect changes in individual performance level and it is possible that new measures of performance and training achievement would be needed. Archival records and research by developers can provide data relevant to this criterion, although decision-makers will have to ultimately make value judgments as to the extent of the anticipated gain.

<u>Degree of Application</u>. Each technology must be evaluated to determine if it provides a means of improving capabilities across a wide field of training applications or whether it is filling a specific perceived need. Limited application may be appropriate if the need is urgent and the technology provides a meaningful solution. However, a more generalizable technology, appropriate across numerous training needs may be viewed as advantageous for most concerns. Generalizability of application of a technology may be characterized by the number and diversity of: (a) AFSCs for which the training is designated; (b) skill levels for which training is appropriate; (c) work centers within units that can utilize the training; (d) tasks included in the training; and/or (e) weapon systems and/or mission areas appropriate for implementation of training. Training developers can supply information relevant to the application of the technology, although user and management input may also provide valid data on the degree of application. All of these data could feed into an overall evaluation of this criterion.

<u>Reliability and Maintainability</u>. The reliability and maintainability of technologies is a contributor to management acceptability, as it was relevant for user acceptability. The same issues discussed previously are pertinent here, too, although managers would consider the impact of this criterion across a number of units and/or applications. Technical support requirements and test data from developers (e.g., MTBF, MTTR) and ratings from users on this criterion could be used as input for managers in making overall evaluations of reliability/maintainability.

<u>Technology Base</u>. Ideally, any effort selected for development into a working system will have been sufficiently studied to ensure that a high confidence exists that will enable the developing organization to minimize the risk of application. Thus, a "broad base" technology would have several to many studies with positive results indicating that there is a strong potential for successful implementation into a typical Air Force unit. A technology with a riskier, more "narrow" base may be seen as being advantageous if

the potential for advancement is great.

This criterion is not independent from those described earlier, instead, it serves as a type of "summary" which reflects the results of preliminary study and evaluation. Specific studies that contribute to the advancement of the technology base include: criticality of training need, degree of application, timeliness of implementation, understandability, user acceptability, reliability, and so on. Those technologies which have been thoroughly researched with positive results in several of these areas are more likely to be successfully implemented, and therefore more worthy of continued R&D, than those technologies which have little or no supporting evidence or research findings. Technology developers could assemble relevant study data for categorization by evaluators to describe the breadth of the technology base.

Economy/Cost. A final consideration relevant to the "Management Acceptability" concept is the issue of cost of technologies. At some point in any developmental effort the funding requirements become a deciding factor. It has been presented here last, not to minimize the recognition of its importance, but to rather highlight the emphasis that should be given on the other non-cost considerations.

The ultimate decision point for those trying to prioritize training technology R&D efforts is: Will it provide sufficient advancement to justify the cost of development? Thus, the "benefits" of the training technology (e.g., improved job performance, reduced training time, improved training effectiveness, greater user satisfaction, improved mission readiness) must be somehow balanced against the "cost."

The issue of how "cost" and "economy" considerations are incorporated into a decision scenario is critical. Dollar costs must be presented in a metric different than "benefits" since they are not necessarily equatable (Colella, 1986). As an example, identified costs (e.g., cost per unit of training/module, cost per training hour, expense of equipment, manning requirements for support of technology) cannot be directly subtracted from accrued benefits (e.g., increased training efficiency, increased job performance, shorter time to upgrade, enhanced readiness). Colella also argued that since military goals are usually stated in terms of combat readiness and not a dollar metric, an individual's "worth" is best described by their contribution to the mission and not as a cost to the organization. Researchers will have to identify the most appropriate "benefits" and "costs" to assess for the purposes of evaluating the training technologies. A common metric, however, across technologies must be used to validly assess differences among technologies.

The assessment of the cost effectiveness of training and training technologies is an issue of great concern for researchers and decision-makers. Much research has been advanced within the military in efforts to quantify the inputs and outcomes of training expenditures and the AL/HRTE may find guidance within work previously done in the area. For example, Hammon and Horowitz

(1989) provided data that support the contention that "quantitative relationships that support the proposition that more flying results in measurably better performance have been developed for the Air Force and Navy" (p. 1). These quantitative relationships include connections between flying training and better landing attempts aboard aircraft carriers and greater bombing accuracy. Examples of other relevant studies include research on automation of classroom instruction (Thoreson, 1988), alternative aircrew devices (Marcus, Patterson, Bennett, & Gershan, 1980), analyses of individual skill training (Solomon, 1986), and use of maintenance data as measures of performance (String & Orlansky, 1981).

Necessary for evaluation is the specification of all costs related to a technology so that valid comparisons and trade-offs can be made. Knapp and Orlansky (1983) provide guidance for the assessment of the life-cycle costs of any course, program, or training technology. In this report, three cost categories are listed which are useful for describing the technology life-cycle (i.e., research/development, initial investment, operations/support) in relation to three types of training (i.e., flight simulators, computer-based training, maintenance simulators). Additional guidance may be found in research by the Marines (cf., Patterson & Adelman, 1981) and the Army (cf., Matlick, Berger, & Rosen, 1980).

C. Assumptions for Application and Use of Evaluative Criteria

The following is a list of assumptions and guidelines for research on the evaluation of the training technologies. These serve to summarize the general process of applying evaluative criteria in the decision-making process.

1. Data will be gathered from multiple sources (e.g., unit-level users, managers at the unit, wing, base, MAJCOM, HQUSAF levels).
2. Multiple sources may be appropriate for some criteria while other criterion evaluations are appropriate from a single source.
3. A single set of criteria will be applied across all technologies to insure a standard upon which to base decisions. It is important the evaluators do not selectively include some criteria while omitting others.
4. Prior to any large-scale effort to systematically assess technologies, each measure must be examined for usefulness and reliability (i.e., validated).
5. Weighting schemes will be required for combining data across sources and criteria. A common metric must be used for each criterion prior to any combining of data.
6. Application of these evaluative criteria can be used in the formulation of an S&T Investment Strategy; analyses will yield information which can be used by decision-makers for prioritization of training technology

R&D efforts.

D. Benefits of Enhanced SLT

One of the major criteria identified in this paper for evaluating potential technology applications was the cost-benefit tradeoff. We felt that it would be helpful at this point in the paper to identify some of the potential benefits associated with training technology applications and enhanced SLT.

Increased training activity at the squadron level has been thought to have potential economic advantage for the Air Force. Economies in cost of formal training (i.e., pipeline and TDY to school funds) are, perhaps, the most frequently cited economic outcome of SLT. Other possible outcomes of SLT include the benefits associated with enhanced effectiveness and efficiency of training such that trainees become better and more quickly equipped to fulfill job requirements. This increased training effectiveness could lead to improved job performance, increased productivity, and overall enhanced mission accomplishment.

At this point in the SLT Research Initiative, it is premature to declare that training at the squadron would result in economic benefits. Nor can specific HSD training technologies be singled out for accelerated R&D and implementation based wholly or partly on cost savings considerations. However, it is possible to identify the types of outcomes that the technologies are purported to produce in relation to their application to SLT. Summary data supplied by training technology managers in response to the AL/HR request for information served as the primary input for this discussion of possible enhancements to and benefits of SLT (see Appendix E for brief descriptions of HSD technologies and Appendix F for the AL/HR request for information).

The program managers' responses were reviewed and the following anticipated benefits extracted. These specific anticipated outcomes have been grouped under general categories of Training Efficiency, Quality of Training, Associated Costs, Manning and Staffing Issues, and Performance Outcomes. Below is a listing of these expected outcomes and the relevant HSD training technologies. (Note. Not all of the training technologies are represented in the following list; only those most appropriate for application to maintenance units were reviewed. These are listed in no particular order.)

<u>Training Efficiency</u>

1. Reduce time required for development of training [AIDA, ATS, ITT].
2. Decrease number of forms and required paperwork [AOTS].
3. Centralize and organize training data [AOTS].
4. Utilize slack machine time for training [Embedded Training].
5. Faster and better initial training, less retraining

required [ITT].
6. Replaces less efficient technologies (e.g., transparencies and grease pencils) [ITT].
7. Eliminates training requirements for certain tasks [JATAT].
8. Decreases training time [Part-Task Training].
9. Reduces need for residential training [Distance Learning].
10. Allows transport of locally developed computer-based training (CBT) to other squadrons [CBT Selection and Implementation Strategies].
11. Allows for more efficiently structured and cost effective manpower, personnel, and training programs [TDMT].

Quality of Training

1. Provide consistent, high quality computer-based training [AIDA, ISS, CBT Selection and Implementation Strategies]; reduce inappropriate development and use of CBT [CBT Selection and Implementation Strategies].
2. Improve training quality and realism [ATS].
3. Provide training problem and deficiency diagnosis [AOTS].
4. Promote standardization and increased control of OJT [AOTS].
5. Simulation of hands-on experience not otherwise available [ITT].
6. Allows more opportunities for individual student - instructor interaction [ITT].
7. Enhances classroom instruction [ICATT].
8. Enhances FTD [Distance Learning].

Associated Costs

1. Reduce TDY funding for school attendance [AOTS, BJS, Embedded Training, Distance Learning].
2. Reduction in classroom instruction time (20-40%) [ICATT].
3. Provides ability to do costing of OJT [TDMT].
4. Identification of the impacts of training decisions on costs, capacities, and resource requirements [TDMT].

Manning and Staffing Issues

1. Increased availability of personnel [AOTS].
2. Utilize slack personnel time for training [Embedded Training].
3. Decrease washback/washout rates (40-80%) [ICATT].
4. Portability of technology allows for on-site training/assistance [IMIS].
5. Provides a mechanism for career field training management and planning [TDMT].

Performance Outcomes

1. Increased readiness and/or mission accomplishment [AOTS, BJS].
2. Accelerated acquisition of complex technical skills [BJS].
3. Increased adaptability of technicians and broadening of job responsibility [BJS].
4. Increase shop productivity [BJS].
5. Increase student proficiency up to 40% [ICATT].

Examination of these reveals a general lack of specificity in the description of the benefits. This lack of precision is most likely an indication of the incomplete state of development of each technology, that is, they are in various development stages and have not been implemented, nor have outcomes been measured. The vagueness of the descriptions also reflects the difficulty of quantification of results which is inherent in training evaluation studies.

Nevertheless, the program managers of the technologies cited above indicated that their respective programs had implications for enhancement of SLT. Further R&D of the technologies and continued SLT research should focus on the application of the technologies to the training needs at the unit level.